Clinic
Techniques of
Optometry

Aseel O. Hamadeh


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osmanybook

Osmany Book
Al-Abdile - Jaoharat Al-Quds Center
Fax : 009 62 64 62 07 62
Mobile: 009 62 79 58 86 52
P.Box: 36146 Amman 11120 Jordan
E-mail: info@osmanybook.com
w w w . o s m a n y b o o k . c o m

■ Clinic Techniques of Optometry

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الاهداء

إلى كل من ساعدني في نشر هذا الكتاب ، إلى عائلتي وخصوصا أبي وأمي، إلى أصدقائي وزملائي في العمل، وأيضا إلى طلابي أهدي هذا الكتاب

For all whom helped me to puplish this book, to my family especially my father and my mother, for my friends and my work team, also for my students I gift this book

Introduction

The stated intention of this book is to be a guide to primary care and examination of the patient's eye.

This book contains five chapters, which talks about several subjects such as how to take case history and how to make the primary examination.

It contains comprehensive and brief information about diseases and pharmaceutics that are important in optometry, it talks about the main instruments that must be learned by any optometrist.

One of these chapters is talking about binocularity and the extra ocular muscles, and how to evaluate the functions of the EOMs.

CHAPTER ONE

Case history and eye examination

Introduction

An accurate history and examination are essential for correct diagnosis and treatment.

The failure to take a history and perform a simple examination can lead to conditions being missed that pose a threat to sight, or even to life.

The rate of onset of visual symptoms gives an indication of the cause. E.g. a sudden deterioration in vision tends to be vascular in origin, whereas a gradual onset suggests a cause such as cataract, the loss of visual field may be characteristic, such as the central field loss of macular degeneration.

Difficulties with work, reading, watching T.V, and managing in the house should be identified.

The patient should also be asked exactly what is worrying them, as visual symptoms often cause great anxiety. Appropriate reassurance then can be given.

Case history

Under standing the patient's ocular and systemic health history.

Purpose: collect information about the patient, and determine which tests need to be performed.

How to take case history:

1. introduce your self
2. patient's demographics (name, age, address)
3. chief complaint (C/C)
4. observe the patient-look
5. patient's ocular history (POHx)
6. patient's medical history (PMHx)
7. family ocular and medical history (FMHx, FOHx)
8. specific visual requirements.
9. social history- alcohol, drugs, smoking.

Particulars of the patient:

- name
- father’s name
- age
- sex
- occupation
- religion
- residential address

Questions about particular symptoms:

Previous ocular history:

1. The patient's red eye may be associated with complications of contact lens wear.
2. A history of sever shortsightedness (myopia) increases the risk of retinal detachment.
3. a history of longsightedness (hypermetropia) and typically the use of reading glasses before the age of 40 increases the risk of closure angle glaucoma.
4. eye drops and eye operations.

Medical history:

The medical history may give clues to the cause of the problem.

Family history:

For any disease that has a genetic component, the age of onset and the severity of disease in affected family members can be very useful information.

Drug history:

Many drugs affect the eye, and should always be considered as a cause of ocular problems.

Examination of the visual system

Vision:

An assessment of visual acuity measures the function of the eye and gives some idea of the patient's disability.

- Distance and near visual acuity must be tested using VA chart.
- Color vision using Ishihara color plates.
- Detect relative degrees of contrast sensitivity using Pelli-Robson chart.

Refraction:

- measurement of patient's most recent optical correction.
- Measurement of anterior corneal curvature using keratometer.
- Measurement of refractive status using retinoscope.
- Subjective measurements of monocular and binocular refractive status at distance and near.

Visual field:

Test of visual field may give clues to the site of any lesion and the diagnosis. It is important to test the visual fiel in any patient with unexplained visual loss.

Using confrontation test. Visual field test is important to know Location of the lesion and diagnosis.

The pupil:

The pupil's reaction to a good light source is a simple way of checking the integrity of the visual pathway.

Measure the afferent and the efferent pupil reaction.

Eye position and movement:

- The appearance of the eyes shows the presence of any large degree of misalignment.
- Using Hirschberg test, the position of the corneal reflections help to confirm whether there is a true squint.
- Patient should be asked if they have any double vision.
- It is important to exclude palsies of the third or sixth cranial nerves, as there may be secondary to life threatening conditions.
- The presence of nystagmus should be noted.

Eyelids, conjunctiva, sclera, and cornea:

Should be performed in good light and with magnification.

You will need an ophthalmoscope with a blue filter for use with fluorescein, and a magnifying aid

- the upper and lower eyelid should be examined.
- Conjunctiva and sclera: look for inflammation.
- Anterior chamber: check for blood and pus, also check chamber depth.

Ophthalmoscopy:

To allow intraocular structures to be seen.

To get a good view, the pupil should be dilated.

Visual acuity

- The term "visual acuity" describes sharpness of vision.

Optometrist tend to use 'visual acuity' to describe the smallest letters read with the optimal refractive correction, while 'vision' to describe the smallest letters that can be read without refractive correction.

Types of visual acuity:

1. ***detection***
   Requires only the perception of the presence or absence of an aspect of the stimuli, not the discrimination of target details.

- landolt C and illiterate E.

2. **recognition**
   Require the recognition or naming of a target.

- snellen letters

3. **direction or localization**
   Identify the relative location, the tilt or the alignment of target.

Snellen scale (notation):

A letters "E" subtends five minutes of arc vertically (assuming the gap width is also set at one minute of arc)

The size of the critical detail (stroke width and gap width) subtends 1/5th of the overall height. (Visual size not physical size).

- To specify a person's VA in terms of snellen notation, a determination is made of the smallest line of letters of the chart that he/she can correctly identify.
- VA in snellen notation is given by the relation:
  VA=D'/D

  Where D' is the standard viewing distance (usually 6 meters) and D is the distance where the normal eye can see this letter and at which each letter of this line subtends 5 minutes of arc.

Decimal form:

Some European countries specify their visual acuities in decimal form, which is simply the decimal of the snellen fraction.

Snellen notation Metric imperial		**decimal**
6/60	20/200	0.10
6/48	20/160	0.13
6/38	20/125	0.16
6/30	20/100	0.20
6/24	20/80	0.25
6/19	20/60	0.32
6/15	20/50	0.40
6/12	20/40	0.50
6/9.5	20/30	0.63
6/7.5	20/25	0.80
6/6	20/20	1.00
6/4.8	20/16	1.25
6/3.8	20/12.5	1.58
6/3	20/10	2.00

Measurements:

1. Visual acuity is typically measured monocularly rather than binocularly.

2. Place the chart at 6 meters (first perform the test without wearing the glasses).

3. place the occluder in front of the eye that is not being evaluated (usually the left eye or the one that is believed to see less)

4. Start first with the big letter and proceed to the smaller ones.

5. If the measurement is reduced (below 6/6) then the test using a pinhole should be done and register the visual acuity using the pinhole.

6. Change the occluder to the other eye and proceed again from the 3rd step.

7. Binocular visual acuity will be measured, because usually binocular visual acuity is slightly better than monocular visual acuity.

8. Evaluate near visual acuity placing a modified snellen chart for near vision at 40 cm. then repeat the test from the 3rd step. (not for all patients).

Distance	VA sc	VA cc	PH
Rt			
Lt			

cc: with correction

sc: without correction

PH: pinhole visual acuity

- When visual acuity is below the largest optotype on the chart, **either the chart is moved closer to the patient or the patient is moved closer** to the chart until the patient can read it. Once the patient is able to read the chart, the letter size and test distance are noted.
  e.g. 6/18 at 2 m = 2/18 = 6/54

if the patient is unable to read the chart at any distance, he or she is tested as follows:

Name	**Abbreviation**	**definition**
Counting fingers	CF	Ability to count fingers at a given distance
Hand motion	HM	Ability to distinguish a hand if it is moving or not in front of the patient's face
Light perception	LP	Ability to distinguish if the eye can perceive any light
No light perception	NLP	Inability to see any light. Total blindness

Distance visual acuity of 6/9 and 6/6 with pinhole in the right eye will be:

Dsc OD 6/9 PH 6/6, **<u>or</u>** OD 6/9 PH 6/6 Dsc

- if any addition letters read on the next line write (+) beside the VA.
- If number of letters missed on the same line write (-) beside the VA.

Infants:

The newborn's visual acuity is approximately 6/120, developing to 6/6 by two years.

Infants VA is taken by:

1. ***optokinetic nystagmus drum:***
   nystagmus is elicited by passing a succession of black and white stripes through the patient's field of vision.

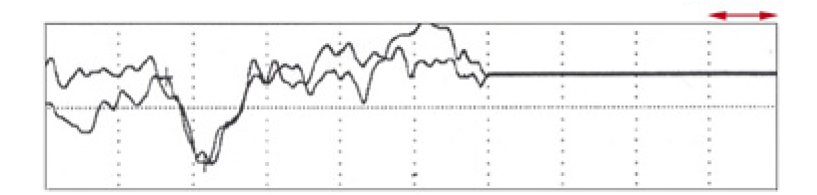
   

2. ***preferential looking:***
   this technique is based on the fact that an infant's attention is more attracted by patterned stimuli than by a homogeneous surface.

   e.g. Cardiff cards

3. ***visual evoked potentials (VEP):***
   a variety of stimuli and recording method using cortical potentials have been used to assess visual acuity in infants.



<u>Low vision and preschool are tested by:</u>

Lea acuity chart



SUBJECTIVE REFRACTION

Aim

Focus Image on the retina

Primary steps:

1. Add the Retinoscopy reading or the habitual reading on the trial frame.

2. Occlude the left eye or the worst eye.

3. Refracting with four steps:

   1... Establish the sphere power.
   2... Refine the Cylinder Axis.
   3... Refine the Cylinder power.
   4... Refine the sphere power.

Step 1: Sphere Establishment

- Add + or – 0.50 Sph lens and ask the patient better with or without.

- Start with + 0.50 always, if the answers were:

  1. Better with: add + 0.50 and continue with the + 0.50 again and again… stop when say better without

  2. Same : add + 0,50 again and again…. stop when say better without

  3. Better Without: go and try the - 0.50
- Add– 0.50 Sph and ask the patient better With or without, if the answers were:

  1. Better with: add - 0.50 and continue with the - 0.50 again and again… stop when say better without

  2. Same : Don’t add – 0.50

3. Without: don't add -0.50.

Note:

- Always find the most plus or least minus lens.
- Don't be over minus because it minify the image and appear smaller and darker that incorrectly perceived as sharper.
- If we add too much minus power or too little plus power the light will focus behind the retina (A young patient may see quite clearly in this situation because they're able to use their accommodation).
- Hypermetrope: may be controlled by accommodation, so may need to do cycloplegic retinoscope to determine the total Hypermetrope.

  Then after 1-2 weeks do the refraction (no cycloplegic affect): push the Sph to the maximum plus can the patient tolerate then back after 3 months from wearing the prescription, repeat the subjective with pushing to more plus.

Step 2: Refine the Cylinder Axis

JCC: Jackson cross cylinder

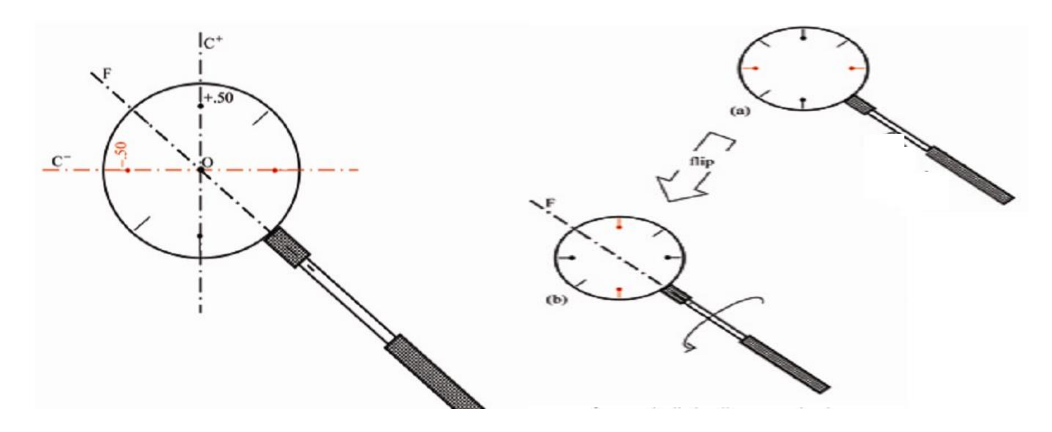
- \- & + cylinders are perpendicular on each other.
- There are four types of JCC:
  1. 0.25
  2. 0.50
  3. 0.75
  4. 1.00

The prescription (refraction) of the 0.50 JCC is: +0.50 -1.00X180

And the Sph equivalent is Zero

JCC Procedure

1. Ask the patient to look at little bigger line.
2. Tell the patient you going to show him **two blur** lenses. Tell me which one is better ***OR*** if they are both the same blurring
3. Hold the JCC in front of the trial frame with the **handle** of the JCC lined up with the lens axis.
4. Flip the JCC and ask which is better, one … **flip** …or two**.**
5. Rotate the cylinder axis toward the red line (Minus Cyl) about 15 degree on the side where the patient preferred the vision.
6. Realign the JCC as above and continue to refine the axis by flipping
7. **If** the patient keeps asking us to move the axis in the same direction, we'll keep changing it in 15 degree, but **If** he reverses the direction we'll adjust it in 10 degree.
8. Realign the JCC as above and continue to refine the axis by flipping
9. **If** the patient keeps asking us to move the axis in the same direction, we'll keep changing it in 10 degree, but **If** he reverses the direction we'll adjust it in 5 degree.
10. The end point when the patient say it is the **Same**



Note:

- If the patient asks 3 times at the same direction from the beginning of the test (this mean rotate 45 degree) this mean the patient doesn't has astigmatism but rather need more minus Sph lenses.
- We have to check the keratometer reading or the retinoscope first.

Step 3: Refine the Cylinder power

1. Now the patient have to look at the best corrected VA
2. Rotate the **JCC** to align the red marking (minus Cyl) with the cylinder marking on the trial lens.
3. Flip the JCC and ask which is better **one … flip …or two** (repeat it if needed)
4. When you flip, the plus Cyl will be aligned with the lens Cyl.
5. Add minus if the patient chooses red (minus Cyl), remove minus if black or green or white (plus Cyl).
6. The end point when the patients say **same**.
7. If you using 0.25 JCC you change the power by 0.25, if you using 0.50 you change the power 0.50, etc….
8. We use 0.75 and 1.00 often with low vision patient.

Note:

- Don't forget to keep a ***spherical equivalent***
  - If you change the cylinder by 0.50, adjust the sphere by 0.25

Ex: pt chooses red, add –0.50 Cyl but also add +0.25 sphere

Ex: pt chooses black, add + 0.50 Cyl but also add –0.25 sphere

- Always find the most plus or least minus cyl lens

Step 4: Sphere Power Refinement

- Now the patient have to look at the best corrected VA
- Add + or – 0.25 Sph and ask the patient better With or without
- Start with + 0.25 always, if the answers were:
    1. Better with: add + 0.25 and continue with the + 0. 25 again and again… stop when say better without
    2. Same : add + 0, 25 again and again…. stop when say better without
    3. Without: go and try the - 0. 25
- When the patient refuses the + 0.25 from the beginning, we do the - 0.25.
- Add – 0. 25 Sph and ask the patient better With or without, if the answers were:
    1. Better with: add - 0. 25 and continue with the - 0. 25 again and again… stop when say better without
    2. Same : Don’t add - 0, 25
    3. Without: Don’t add any lenses.

Assurance tests

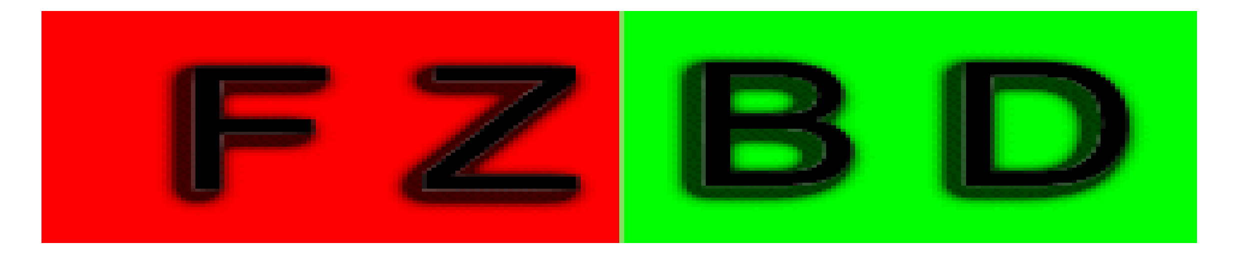
+0.75 Blur test:

To find out if we are over minus or less plus.

- Used just for VA 6/6 with correction.
- If the patient has the optimum correction he will see the 6/6 line **unreadable**
- You must say to the patient: “I'm going to add this blurry lens, you have to try hard to read this line (point to the 6/6 line)”
- If the patient can read the letters, we add +0.25 and we say: “it is now more blurry, but you have to try hard to read this line (point to the 6/6 line)”, if still read it, continue by adding more +0.25 until the patient can’t read the 6/6 line.

The red-green test:

- The duochrome (red/green) test is a refraction refinement procedure for the sphere that is used at the end of the refraction procedure, and used on each eye individually.
- this test tells you if the prescription has too much plus sphere, or too much minus sphere, or if the focal point is exactly on the retina



Procedure

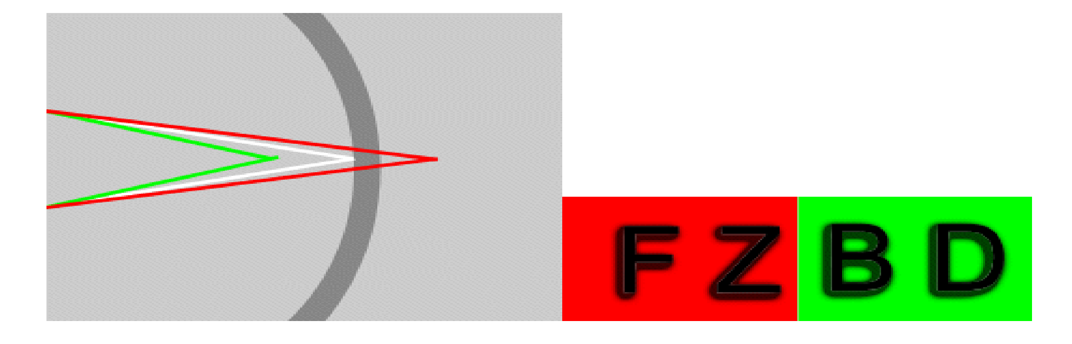
1. The fellow eye (the eye which is not tested) is occluded
2. The patient views a line with the red/green slide in place in the acuity chart. Half the letters have the red background and the other half have the green background.
3. The patient is asked "which letters look darker and sharper, the letters in the green, or the letter in the red".
4. If the patient answers "red", then - 0.25 D Sph is added. If the patient answers "green", then + 0.25 D Sph power is added.
5. The procedure is repeated until the letters look equally dark and sharp in the red and the green.

   It is preferred to keep the patient barely "in the green" so that the patient has a small amount of accommodative control.

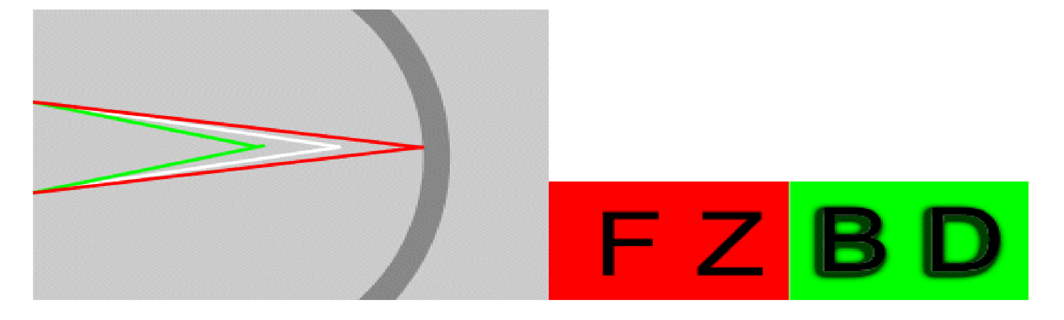
6. The test is not dependent upon colour vision. If the patient is red/green confused, you can just identify "letter on the right side of the line" vs. "letters on the left side of the line".

How it works

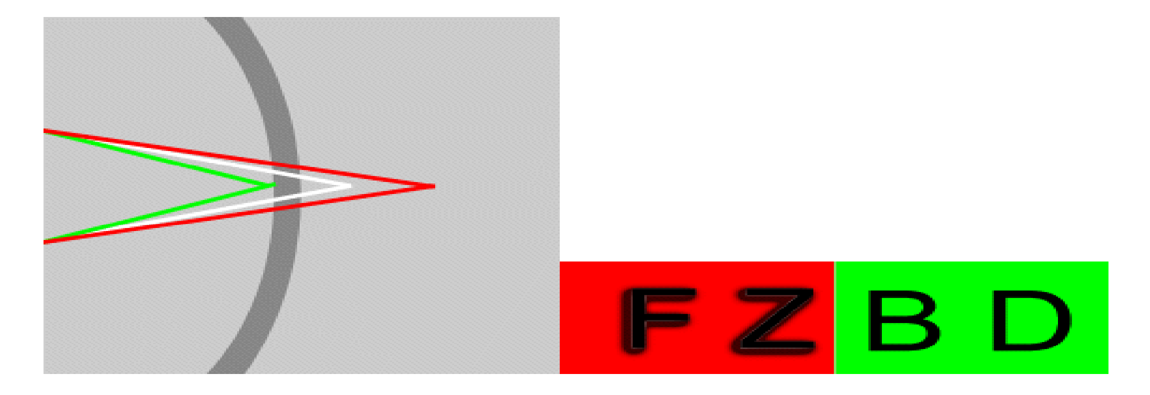
- If white light is focused on the retina, green light (shorter wavelength) will focus in front of the retina and red light (longer wavelength) will focus behind the retina …… Letters on a green or red background will appear equally blurry.



- If there is too much plus correction, then red light will fall on the retina and appear to be in focus while green light will appear to be out of focus



- If there is too much minus correction, then green light will be in focus on the retina and red light will be out of focus



ADDITIONAL TESTS

Additional test for astigmatism

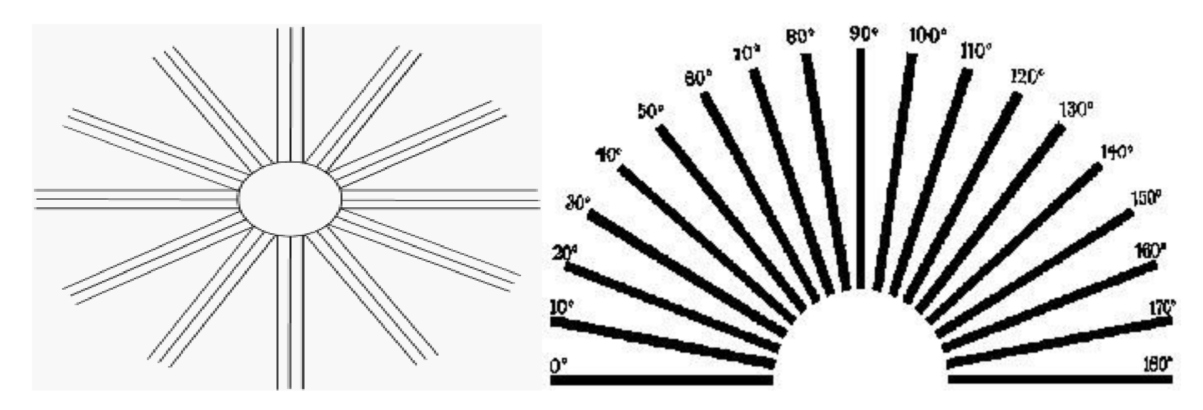
These tests help to determine the axis of the cylinder, it is a good starting point but not accurate as JCC.

THERE ARE THREE TYPES:

1. **Astigmatic dials** (Daisy wheel)
2. **Stenopeic Slit**
3. **“Fishing for cyl” technique**

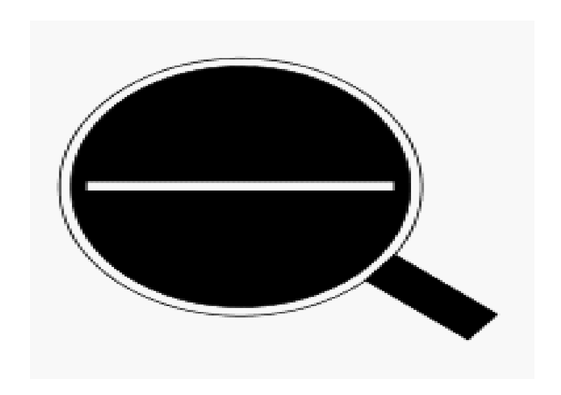
Astigmatic dials (Daisy wheel)

- used on each eye individually
- If the patient emmetrope or myope or hypermetrope, the patient will see all line equal sharp or equal blur
- If the patient with astigmatism, one line will look sharp and bright. The cyl axis will be perpendicular on the sharpest line.



Stenopeic Slit

- Estimate the axis of astigmatism, because the slit eliminates light rays from all except one axis.
- When the Stenopeic slit align with one of the astigmatism axis of the conoid strum, the image will look sharp.
- The perpendicular axis is the other astigmatism axis of the conoid strum.



Fishing for cyl:

- Add a cylinder lens (0.50 if the patient has good acuity, more depending on VA) as you find from the objective
- Turn the cylinder axis knob to rotate the cylinder clockwise while asking the patient to tell you if at any time the chart becomes blur.
- Return to the original axis and rotate the axis anticlockwise.
- When the patient responds that it is getting blur, try to put the axis in the middle of the blur area and begin JCC

Now:

What if the patient is only myope or hypermetrope when doing retinoscopy?

What steps we have to do?

Do we have to check the cyl?

- The steps are:

  Number 1.. Establish the sphere power .

  Number 2 .. Look for cylinder (if founded do 3 and 4)
  Number 3 .. Refine the Cylinder Axis .
  Number 4 .. Refine the Cylinder power .
  Number 5 .. Refine the sphere power.

Determine the addition for presbyopic patients

1. *Visual Acuity*
2. *Refraction:* determining the refractive error (first distance then near):
   - Plus lens to clear near vision
   - Balanced range of accommodation (NRA/PRA):

     NRA is a measure of maximum ability to relax accommodation while maintaining clear.

     PRA is a measure of the maximum ability to accommodate while maintaining clear.

     The sum of the lens power required to achieve the NRA endpoint and half of the relative accommodative amplitude (difference between the NRA and the PRA).
3. Amplitude of accommodation (AA)
      - push-up / minus lens to blur
4. Addition relating to age

Age	**Addition**
40	+1.00
45	+1.50
50	+2.00
55	+2.50
60	+3.00

PINHOLE VISUAL ACUITY

- Pinhole instrument is used to determine if a decrease in vision is correctable by lenses.

(Viewing the acuity chart through a pinhole will increase the patient's depth of focus and decrease the retinal blur. If the retina and visual pathway are free of abnormalities the patient's acuity will improve).

- Pinhole acuities are taken when the VA is worse than **20/30** (6/9) at distance and near through the habitual or induced correction.

We use:

- Acuity chart.
- Pinhole disc (PH).
- Occluder.

Procedure:

1. The patient wears his distance correction while looking at the distance VA chart.
   (Pinhole acuities are taken only at distance).
2. The patient is asked to occlude the eye not being tested. If you want to test both eyes, test the right eye first.
3. Instruct the patient to position the PH disc until the chart is as clear as it will get and then read the smallest line of letters he can.
4. Encourage the patient to read the next smallest line, even if he has to guess. Continue until the patient has missed more than half of the letters on a line.

Recording:

- Write "PH" followed by the visual acuity. This notation is usually recorded next to the distance VA through correction.
- "PH NI" may be indicate no improvement in VA with the pinhole.

Expected findings:

- If the cause of the decreased acuity is due to an uncorrected refractive error, the visual acuity will improve through the pinhole.
- If the cause of decreased acuity is not optically based, no improvement, and possibly a decrease, will occur through the pinhole.

MEASURING THE (IPD)

Definition:

The distance from the center of one pupil to the center of the other pupil, measured in millimeters.

Distance IPD:

The most common method used to measure PD:

1. We use a simple millimeter ruler, commonly referred to as PD ruler.
2. The optometrist is placed directly in front of the patient, at the same level, and at a distance of about 40 cm.
3. The PD ruler is positioned across the patient's nose with the measuring edge tilted back so that it resets on the most recessed part of the nose.
4. The optometrist holds the PD ruler between thumb and forefinger and steadies the hand by placing the remaining three fingers against the patient's head.
5. The optometrist closes the right eye and sights with the left.
6. The patient is instructed to look at the optometrist's open eye while the optometrist lines up the zero mark of the ruler with the center of the patient's pupil.
7. When the zero mark is lined up correctly, the optometrist closes the left eye and opens the right.
8. The patient is instructed to look at the optometrist's open eye.
9. The PD for the distance prescription is read off as that mark falling in the center of the patient's left pupil.
10. When difficulty is experienced in determining the exact center of the pupil, the edge of the pupil may be used as a measuring point if both pupils are the same size. Measurement is read from the left side of one pupil to the left side of the other.
11. When a person has dark or unequally sized pupils, in this case the optometrist may use the limbus edges.

Common difficulties and their solutions:

Patient is strabismic:

Since the PD ruler method of measurement may then give an artificially high or low reading. To determine a true readings, simply cover the patient’s eye not being observed.

Patient is uncooperative child:

The optometrist may have to take canthus-to-canthus measurement. (The canthus is the corner of the eye where the upper and lower lids meet).

Near IPD:

1. The optometrist is positioned at 40 cm.
2. Optometrist instruct the patient to fixate on his nose.
3. Place the zero point of the PD ruler at center of the patient’s right pupil.
4. Scale marking at center of patient’s left pupil is read.

PUPILS EXAMINATION

- This test is used to assess the afferent and efferent neurological pathways responsible for pupillary function.

We use:

- Penlight or transilluminator.
- Distance fixation target.

Procedure:

1. keep room illumination as dim as possible, but permits a clear view of both of the patient's pupils.
2. Position yourself within 25 cm of the patient, but not in his line of sight.
3. Instruct the patient to remove his spectacles, and look at the distance target.
4. Shine the light into his right eye and observe the size and the speed of the pupillary construction in this eye, then repeat this step for 2 times.
5. Shine the light into the right eye and observe the size and the speed of the pupillary construction in the left eye, then repeat this step for 4 times.
6. Repeat step 4 and 5 shining the light into the left eye, again observing the direct and consensual responses of the appropriate pupils.
7. Swinging flashlight test: move the light between the eyes rapidly leaving it on each eye for 3 to 5 seconds. Observe the response (dilation or construction) and the size of each pupil at the moment when the light first arrives there and during the 3 to 5 second observation period. Be sure to shine an equal intensity of light into each eye, this step should be repeated for 2 or 3 complete circle.
8. Throughout the test, judge the roundness of each pupil.
9. If the pupils are unequal in size, perform the dim-bright pupillary test.
10. If either or both pupils fail to respond directly or consensually, or if their responses are sluggish, test the accommodative response of the pupil.

Recording:

- If all the pupillary responses are normal, write PERRL (pupils equal round responsive to light) no MG (no Marcus Gunn response). Record only those that apply, omitting the others.
- Separately describe abnormalities, such as inequality of size, shape, or rate of response.
- If pupillary escape is observed on the swinging flashlight test, record +MG (positive Marcus Gunn) or +RAPD (positive relative afferent pupillary defect), followed by the affected eye.

Color perception

Introduction:

The rods and cones contain light sensitive chemicals known as photopigments.

When light is absorbed in a photoreceptor it causes a chemical change in the photopigments, this gives the rise to an electrical signal that is conducted via a network of nervous connections within the thickness of the retina to the optic nerve, which sends the signal off the brain.

There are four types of photopigments, Rod's photopigment (Rhodopsin) and 3 different cone photopigments which have maximum sensitivity in the long wave (red), medium wave (green) and short wave (blue) parts of the spectrum. The three types of cone photoreceptors are not uniformly distributed over the retina, it turns out that the blue cones account for only about 3% of the total number of cone photoreceptors. It would seem that the red and green photoreceptors do most of the work for fine vision.

Cone	Peak sensitivity	Color
S cone	445 nm	Blue
M cone	535 nm	Green
L cone	570 nm	Red

Color blindness or deficiency:

Normal person uses three types of cones that working normally (**trichromats**).

Color deficiency arises when one of these photopigments is missing (**dichromatism**), or when an abnormal photopigments is present which differs in sensitivity from the corresponding normal pigment (**anomalous trichromatism**).

There are three types of color deficiency and differences in severity within each type: protan, deutan and traitan.

Dichromats:

Use two types of cones, one of the three color receptors is missing.

1. ***protanopia:***
   The long wave photopigment is missing, causing loss of sensitivity to red light, and there is typically confusion between reds, greens and browns, and between various shades of purple.

2. ***deutanopia:***
   The medium wave photopigment is missing, causing loss of sensitivity to green light. All colors are seen and there is typically confusion between reds and greens, and between blue and purples.

3. ***traitanopia:***
   The short wave photopigment is missing, causing loss of sensitivity to blue light and confusion between blue and green.

Anomalous trichromatism:

Color vision deficiency is more commonly caused by altered sensitivity in one of the three receptors mechanisms, rather than by complete absence of one of them. The wavelength at which maximum sensitivity occurs is shifted from the normal position.

There are three forms of anomalous trichromatism, depending upon which mechanism has altered sensitivity:

1. ***protananomaly:***
   The sensitivity of the red receptor mechanism is displaced from the normal position.

2. ***deutranomaly:***
   This is the most common form of color vision deficiency. The peak sensitivity of the middle wave receptor is displaced.

3. ***traitanomaly:***
   A rare condition, with altered sensitivity of the blue receptor mechanism.

Monochromats:

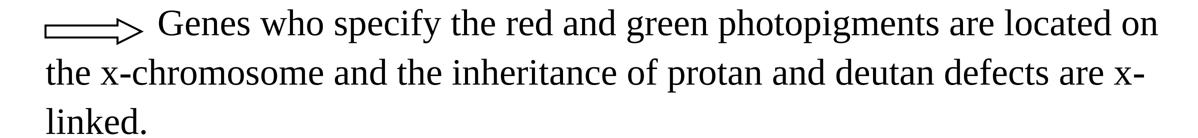
Use just one type of cones.

Achromatopsia:

Absence of all types of cones, total inability to distinguish color only have night vision (total color blindness, affected patients see things in shades of white, gray and black).

In ophthalmic examination of the eye, retina appears normal and visual acuity could be normal.

The achromates develops involuntary eye movement or nystagmus.



⇨ Genes who specify the red and green photopigments are located on the x-chromosome and the inheritance of protan and deutan defects are x-linked.

⇨ The gene specifies the blue pigment is located on the chromosome 7 and traitan color deficiency inherited as an autosomal dominant trait.

Acquired color vision defect:

Can occur as a result of:

1. ***disease:***
   as glaucoma (blue-yellow defect), diabetic retinopathy (blue color defect).

2. ***injury***
3. ***exposure to chemicals or medication***
4. ***heavy tobacco smoking:***
   This typically take the form of a red-green disturbance.

5. ***age:***
   the crystalline lens become less transparent with age. The lens absorbs more blue light, leaving the lens lightly yellow appearance.

Comparison between inherited and acquired defects

Inherited	Acquired
Present at birth	Appear later in life
Permanent and unchanging	Severity may fluctuate or be reversible
Limited range of defects	Many range of defects, hard to classify
Normal visual acuity	VA often affected
Predominantly found in males	Found in both males and females
Both eyes are the same	The eyes may differ from each other
Predominantly red-green defect	Often a blue defect

Testing for color blindness:

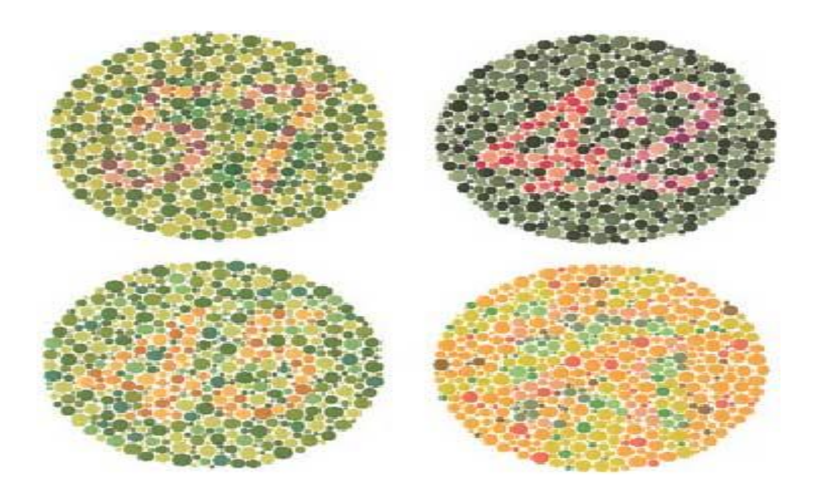
Pseudoisochromatic tests:

These tests require identification of a colored figure. These tests are simple to use and have the widest application for screening.

Pseudoisochromatic test is:

1. Ishihara plates.
2. Matsubara test (pictures for children)
3. Guy's color test (test for children with upper-case letters)
4. HRR test
5. City university test.

Ishihara plates:



The most widely used examples of Pseudoisochromatic test, they are only useful for screening (identify individuals with normal or abnormal color vision) in some new models that can give indication of the severity of color deficiency.

Each plate is made up of irregular colored dots, which conceal a hidden figure, typically numeral. The figure can easily be seen by color normals, but not by color deficient.

This type of test can be used to give a rapid screening.

Each Pseudoisochromatic plate is shown for about 4 seconds and immediate verbal identification of the figure is required. The testing distance should be 75 cm.

There are many figure designs implicated in ishihara test, these include:

1. ***Vanishing design***: a figure that can be seen by people with normal color vision but not by the color deficient.
2. ***Transformation design***: a number is seen by people with normal color vision and a different one by color deficient observer.
3. ***Hidden digit design***: a number can be seen by the color deficient but not by those with normal color vision.
4. ***Classification plates***: designed to distinguish between red deficient and green deficient vision, normal patients can see two numbers, people with red deficiency can see one and those with a green deficiency can see the other.

City university traitan test:



It contains five plates of vanishing type. Three plates are used for screening the defect and the other two plates are used to determine the severity of the defect.

The plates contain geometrical shapes rather than numbers.

HRR plates:



The test contain 24 plates of the vanishing type.

The HRR test can be used for screening of the traitan defect and could determine the severity of red-green defect.

<u>CHAPTER TWO</u>

ocular diseases

AMBLYOPIA (LAZY EYE)

Definition:

Is the eye condition noted by reduced vision not correctable by glasses or contact lenses and is not due to any eye disease.

The brain, for some reason, does not fully acknowledge the images seen by the amblyopic eye. This almost always affects only one eye but may manifest with reduction of vision in both eyes. It is estimated that three percent of children under six have some form of amblyopia.

Amblyopia Signs and Symptoms

Amblyopia generally develops in young children, before age six, and symptoms often are noted by parents, caregivers or health-care professionals. These symptoms include:

- Squinting or completely closing one eye to see
- Overall poor visual acuity
- Eyestrain
- Headaches

Causes of Amblyopia

Anything that interferes with clear vision in either eye during the critical period (birth to 6 years of age) can result in amblyopia.

1. The most common causes of amblyopia are constant strabismus.
2. anisometropia.
3. blockage of an eye due to trauma, lid droop, etc.

4. strong uncorrected refractive errors.

If one eye sees clearly and the other sees a blur, the good eye and brain will inhibit the eye with the blur. Thus, amblyopia is a neurologically active process. The inhibition process can result in a permanent decrease in the vision in that eye that can not be corrected with glasses, lenses, or Lasik surgery.

Diagnosis of Amblyopia

Since amblyopia usually occurs in one eye only, many parents and children may be unaware of the condition. Far too many parents fail to take their infants and toddlers in for an early comprehensive vision examination and many children go undiagnosed until they have their eyes examined at the eye doctor's office at a later age.

The most important diagnostic tools are the special visual acuity tests other than the standard 20/20 letter charts currently used by schools, pediatricians and eye doctors. Examination with cycloplegic drops can be necessary to detect this condition in the young.

Treatment of Amblyopia

Amblyopic children can be treated with vision therapy (which often includes patching one eye), atropine eye drops, the correct prescription for nearsightedness or farsightedness, or surgery.

Vision therapy exercises the eyes and helps both eyes work as a team. Vision therapy for someone with amblyopia forces the brain to see through the amblyopic eye, thus restoring vision.

Sometimes the eye doctor or vision therapist will place a patch over the stronger eye to force the weaker eye to learn to see. Patching may be required for several hours each day or even all day long and may continue for weeks or months. If you have a lot of trouble with your child taking the patch off, you might consider a prosthetic contact lens that is specially designed to block vision in one eye but is colored to closely match the other eye.

In some children, atropine eye drops have been used to treat amblyopia instead of an eye patch. One drop is placed in your child's good eye each day (your eye doctor will instruct you). Atropine blurs vision in the good eye, which forces your child to use the eye with amblyopia more, to strengthen it. One advantage is that it doesn't require your constant vigilance to make sure your child wears the patch.



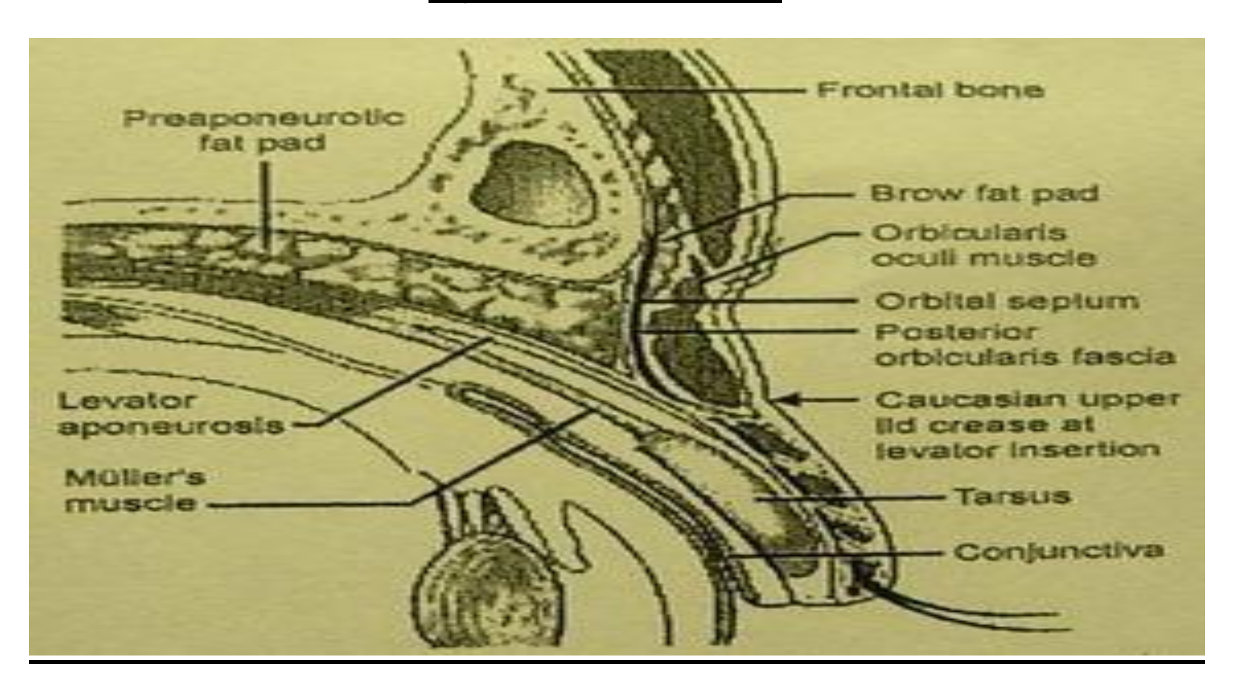
You can help your child accept patching more readily. Here, Fun Patches require no adhesive because they slide onto the temple of an eyeglass frame.

However, atropine does have side effects that should be considered: light sensitivity (because the eye is constantly dilated), flushing and possible paralysis of the ciliary muscle after long-term atropine use, which could affect the eye's accommodation, or ability to change focus.

If your child has become amblyopic due to a strong uncorrected refractive error or a large difference between the refractive errors of both eyes, amblyopia can be treated with eyeglasses or contact lenses in the correct prescription. Your eye care practitioner may prescribe an eye patch along with the new glasses or contact lenses.

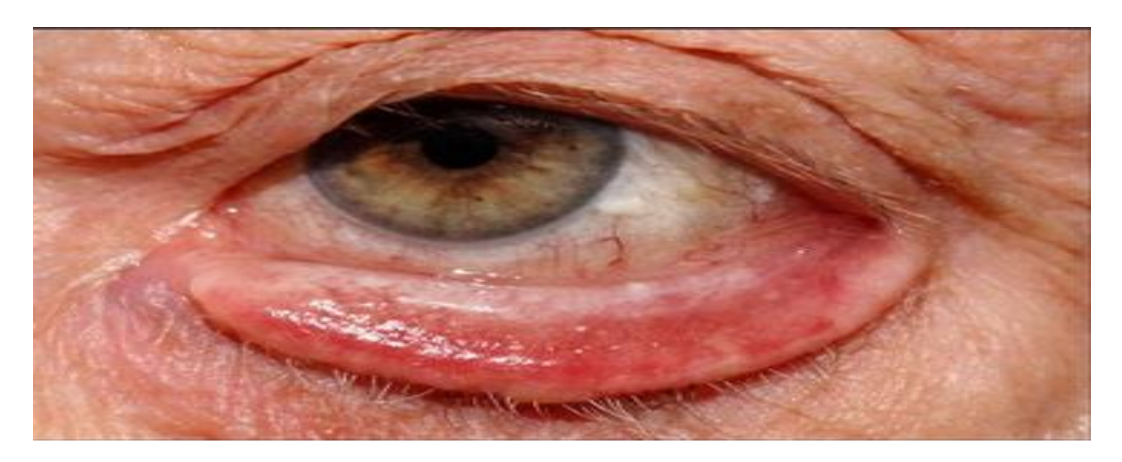
Surgery is best for amblyopic children with an underlying physical problem, such as strabismus. The surgery corrects the muscle problem that causes strabismus so the eyes can focus together and see properly.

Eyelids disorders



Ectropion

Is outward turning of lid margin and sagging eyelid that leaves the eye exposed and dry.



Signs and symptoms:

1. corneal exposure: excessive tearing
2. red, irritated eyelid, burning

3. gritty, sandy feeling
4. Keratinization of the palpebral conjunctiva.
5. visual loss

Complications:

1. eye infections
2. corneal abrasions
3. corneal ulcer
4. Conjunctival keratinization
5. Epiphora and pain
6. punctual stenosis

Treatment:

1. Medical: antibiotics, artificial tears.
2. surgical

Entropion

Is an inward turning of lid margin



Signs and symptoms:

1. excessive tearing
2. eye irritation
3. redness
4. eye discomfort
5. decrease vision if the cornea is damaged

Complications:

1. Corneal breakdown

2. ulcer formation
3. Epiphora
4. pain

Treatment:

1. Medical: lubricating eye drops and ointment, plucking the offending eyelashes.
2. surgical

Ptosis

Is an abnormally low position (drooping) of the upper eyelid.



Symptoms:

1. drooping of the upper eyelid in one or both eyes
2. undesirable facial appearance due to drooping of the upper eyelid
3. elevated chin in sever ptosis
4. stiff nick due to constant chin elevation
5. eye fatigue from straining to keep eye open
6. decreased vision when the droop is severe and covers the pupil

Causes of ptosis:

1. myogenic: The skeletal muscle fibers of the LPS are replaced by fibro adipose tissue
2. neurogenic: caused by innervational defect
3. mechanical: mass defect
4. aponeurotic: due to failure of the levator aponeurosis to insert at its normal position on the anterior tarsus
5. traumatic: caused by direct trauma

Ptosis measurement:

1. simple observation
2. vertical fissure height
3. levator function
4. upper lid excursion

Indication of treatment of ptosis:

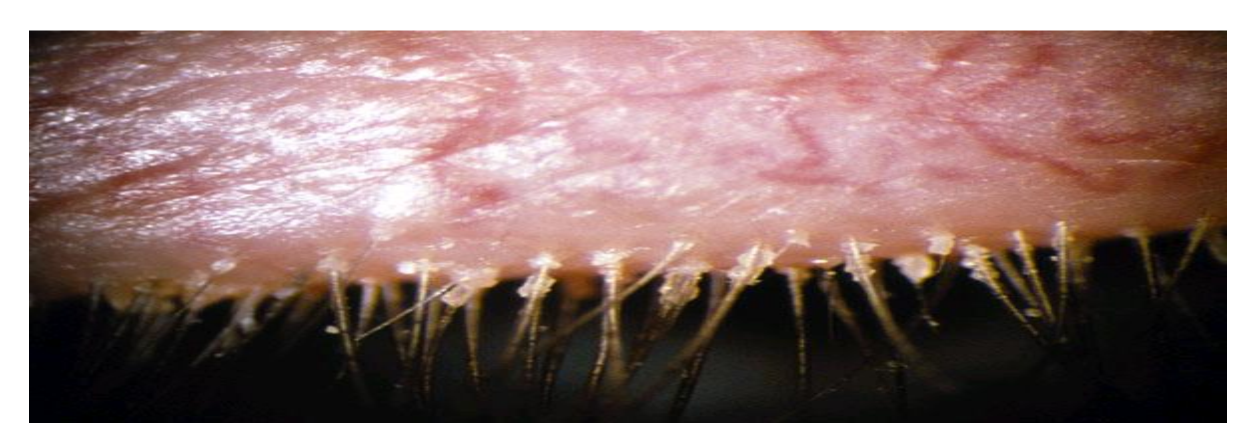
1. cosmetic
2. visual

Treatment:

1. involutional: surgery
2. myogenic and neurogenic: systemic treatment of possibly life threatening problems
3. mechanical: treat underlying cause

Blepharitis

It is a very common condition of chronic eyelid inflammation.



Signs and Symptoms:

1. redness of the eyes
2. itching and irritation of the eyelids
3. tired, sore eyes worse in the morning
4. reduction in the number of the eyelashes
5. Obstruction and plugging of the meibomian ducts.
6. cloudy meibomian secretion
7. injection of the lid margin
8. tear film abnormalities

Treatment:

1. Softening of lid margin debris and oils: Apply a warm wet compress to the lids for about two minutes.
2. Mechanical removal of lid margin debris: Use facial soap or non-burning baby shampoo. Gently and repeatedly rub along the lid margins while eyes are closed.
3. Antibiotic reduction of lid margin bacteria (at the discretion of your physician): After lid margin cleaning, spread small amount of prescription antibiotic ophthalmic ointment with finger tip along lid fissure while eyes closed.
4. Avoid the use of eye make-up until symptoms subside.

Chalazion

Is a granuloma of the lipid-secreting meibomian glands that lie in the lid.



Cause:

It is the result of a blocked duct, with local reaction to the accumulation of lipid.

Signs and symptoms:

1. swelling of the eyelid
2. eyelid tenderness
3. sensitivity to light
4. increased tearing
5. heaviness of the eyelid

Treatment:

1. topical antibiotics drops or ointment
2. smaller lesions may be injected with corticosteroids
3. larger lesions may be surgically removed

Stye

Is an infection of the subaqueous glands of zeis at the base of the eyelashes, or an infection of sweat glands of moll.

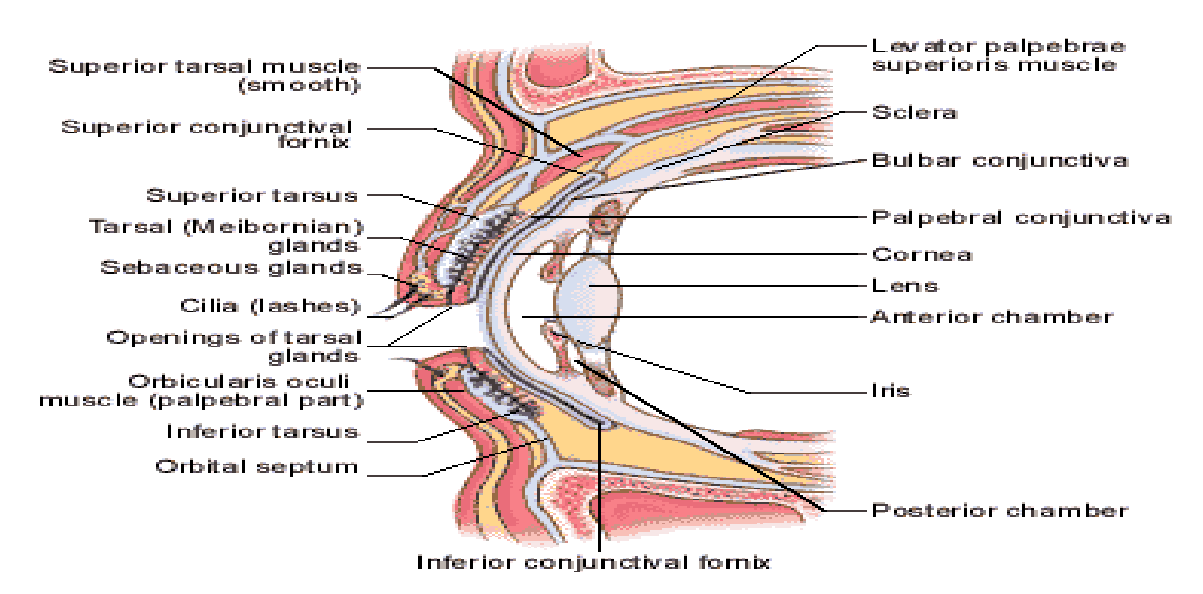


Treatment:

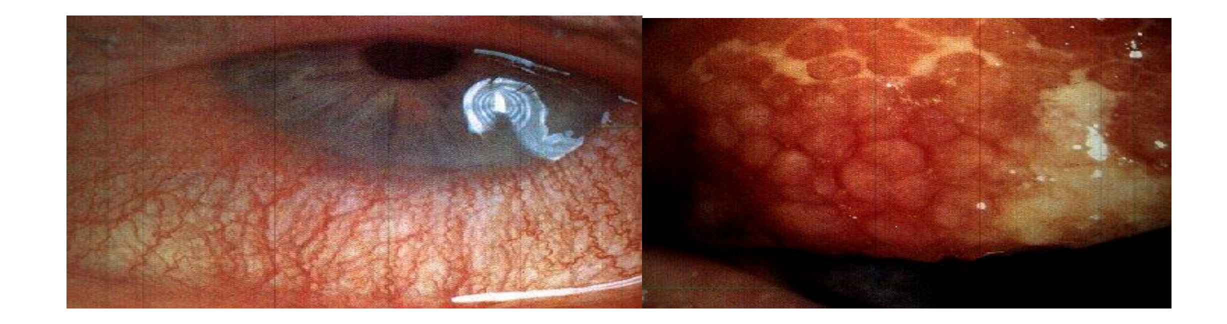
1. hygiene
2. warm compresses to help it to discharge
3. chloramphenicol ointment should be used

Stye will last from up to 3 weeks to 2 yrs if not treated and only 1 week if treated properly.

Conjunctival disorders



Conjunctivitis



Bacterial conjunctivitis:

Clinical features:

1. palpebral redness
2. purulent discharge
3. papillae
4. edema of eyelids
5. ocular irritation

Treatment:

1. culture
2. warm compresses
3. clean lids of discharge
4. Topical antibiotics.

Viral conjunctivitis:

Symptoms:

1. itching
2. burning
3. palpebral redness

Signs:

1. watery discharge
2. Conjunctival follicles
3. Enlarged pre-auricular lymph nodes.
4. maybe also lid edema.
5. excessive lacrimation

Treatment:

Viral conjunctivitis is generally a self limiting condition.

- antibiotic eye drops provide symptomatic relief and help prevent secondary bacterial infection
- hygiene

the period of infection is often longer than with bacterial pathogens

- Steroid eye drops may be necessary for some patients with chronic infection.

Allergic conjunctivitis:

This may be divided into acute and chronic forms:

1. acute (hayfever conjunctivitis)
   Signs and symptoms:
   - itchiness
   - conjunctival swelling
   - lacrimation
2. vernal conjunctivitis (spring catarrh)
   Signs and symptoms:
   - itchiness
   - photophobia
   - lacrimation
   - papillary conjunctivitis on the upper tarsal plate
   - Limbal follicles and white spots.
   - Punctuate lesions on the corneal epithelium

Treatment:

- Antihistamines and mast cell stabilizers.
- Topical steroids in sever cases.

Note:

Contact lens wearers may develop an allergic reaction to their lenses or to lens cleaning materials leading to a ***giant papillary conjunctivitis (GPC)*** with a mucoid discharge.

This may response to topical treatment with mast cell stabilizers.

It is often necessary to stop lens wear for a period or even permanently.

Trachoma:

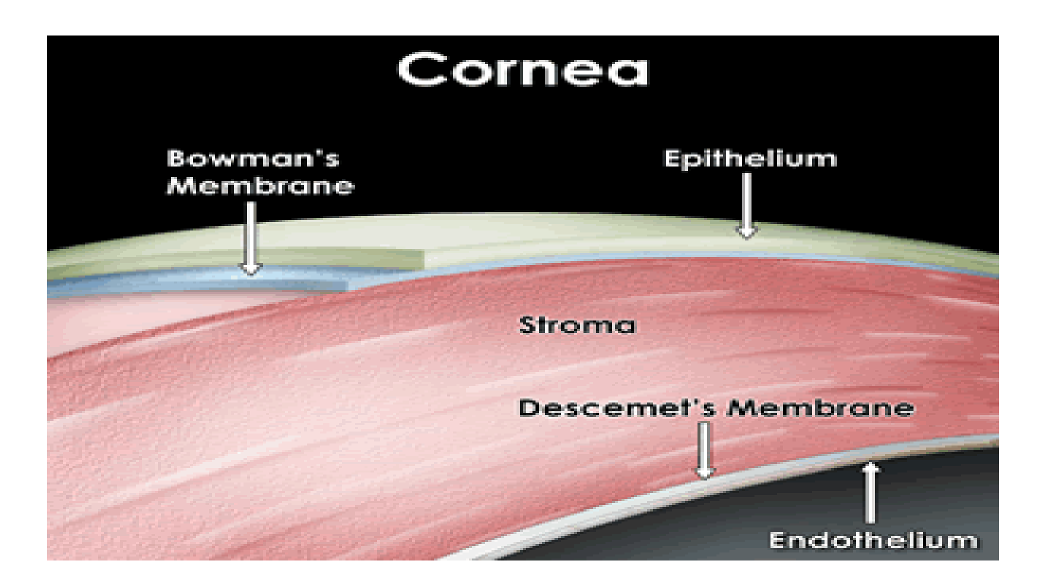


- This is the commonest infective cause of blindness in the world.
- The housefly acts as a vector and the disease is encouraged by poor hygiene and overcrowding in a dry, hot climates
- The hallmark of the disease is subconjunctival fibrosis caused by frequent re-infections associated with the unhygienic condition.
- Blindness may occur due to corneal scarring from recurrent Keratitis and Trichiasis.

Treatment:

- oral or topical tetracycline or erythromycin.
- Entropion and Trichiasis require surgical correction.

Corneal disorders



Keratitis:

Bacterial Keratitis


Figure 2

Signs and symptoms:

1. pain
2. purulent discharge
3. ciliary injection
4. visual impairment (sever if the visual axis is involved)
5. hypopyon sometimes (a mass of white cells collected in the anterior chamber)
6. white corneal opacity which can often be seen with the naked eye.

Treatment:

1. gram staining and culture
2. topical antibiotics (often with dual therapy)
3. corneal perforate (treated initially with tissue adhesives and a subsequent corneal graft)
4. A persist scar may also require a corneal graft.

Acanthamoeba Keratitis



Risk factor:

The infection is becoming more common due to the increasing use of soft contact lenses

Signs and symptoms:

1. painful
2. Prominence of the corneal nerves results.

Treatment:

1. culture
2. topical chlorhexidine
3. polyhexamethylene biguanide (PHMB)
4. propamidine

Fungal Keratitis



an inflammation of the eye's cornea that results from infection by a fungal organism**.**

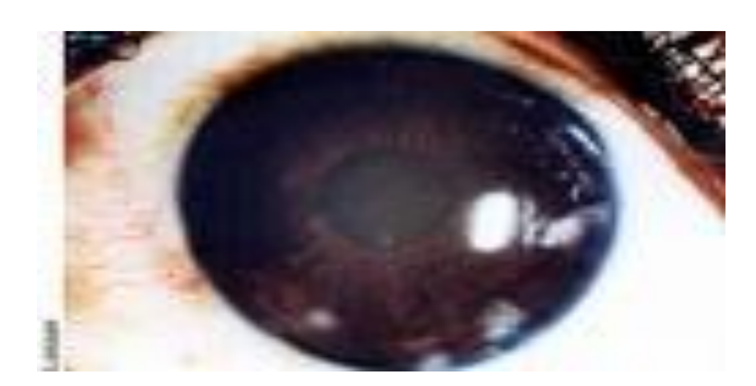
Signs and symptoms:

1. blurred vision
2. red and painful eye that does not improve when contact lenses are removed, or on antibiotic treatment
3. increased sensitivity to light(photophobia)
4. Excessive tearing or discharge.
5. the eyelids and adnexa involved shows edema and redness
6. Conjunctiva is chemosed.
7. Ulcer may be present.
8. Satellite lesions in the surrounding cornea.
9. it may extend to the posterior segment to cause endophthalmitis in later stages, leading to the destruction of the eye

Treatment:

Topical eye drops.

Interstitial Keratitis



This term is used for any Keratitis that affects the corneal stroma without epithelial involvement.

Causes:

Syphilis

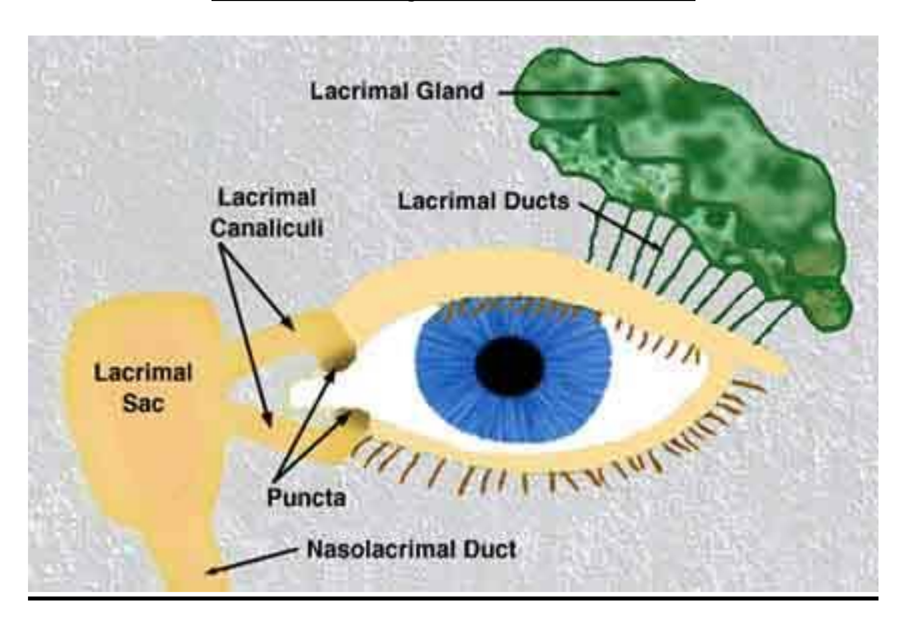
Signs and symptoms:

1. mid stromal scar
2. outline of blood vessels

Treatment:

Corneal grafting.

Lacrimal system disorders



Epiphora

is overflow of tears onto the face. A clinical sign or condition that constitutes insufficient tear film drainage from the eyes in that tears will drain down the face rather than through the nasolacrimal system.

Etiology:

1. Trichiasis
2. Entropion
3. Ectropion
4. Punctal, canalicular or nasolacrimal duct obstruction.
5. aging
6. infection
7. rhinitis
8. Failure of the nasolacrimal duct to open.

Diagnosis:

1. history presentation
2. observation of the lids
3. Fluorescein dye can be used to examine for punctal reflux by pressing on the canaliculi in which the clinician should note resistance of reflux as it irrigates through the punctum into the nose

Management:

1. lid repair is indicated
2. Punctal irrigation is also required
3. nasolacrimal duct probe is used and a tube replacement

Obstruction of tear drainage

The tear drainage system may become blocked at any point, the most common site is the nasolacrimal duct.

History:

- The chief complaint will be watering eye sometimes associated with stickiness.
- The eye is white.
- Symptoms worse in the wind or cold weather.
- History of previous trauma or infection.

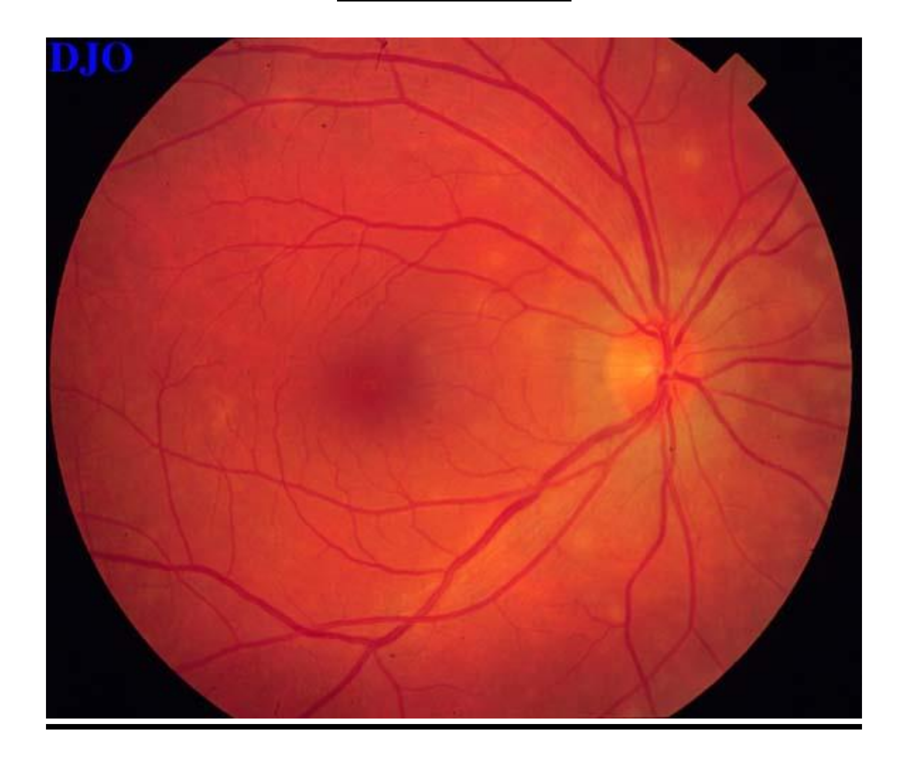
Signs:

1. Stenosed punctum appear on slit lamp.
2. Obstruction beyond the punctum

Treatment:

1. Exclude other ocular diseases that may contribute to watering.
2. Surgery.

Glaucoma



Definition:

Are mixed group of disorders that have some common features:

1. Optic disc cupping
2. Visual field loss
3. Raised IOP
   - Raised IOP without optic disc damage and visual field loss is called ocular hypertension.
   - Glaucoma in the absence of high pressure is known as low or normal tension glaucoma.

Classifications:

- Primary versus secondary
- Open versus closed
- Congenital versus acquired

Primary open angle glaucoma

Pathogenesis:

1. Impaired drainage of aqueous humour which causes raise of IOP, which transmitted to the optic disc where nerve fiber damage occur.
2. Impairment of the optic nerve blood supply
3. Aspects of optic nerve head structure.
   - The 2nd and 3rd points are called glaucoma when the IOP is normal or low.

Risk factors:

1. Genetic
2. Increasing age
3. Diabetes mellitus
4. Myopia
5. Black race

Clinical features:

1. No symptoms until it is so advanced
2. The central vision is threatened
3. Does not present with head or eye pain
4. Does not present with loss of visual acuity.
5. Raised IOP
6. Optic disc cupping
7. Peripheral visual field loss.

Examination:

1. Tonometer (for measuring IOP): the normal IOP 11-21 mmHg, the average is 15.5 mmHg.
2. Optic disc examination is essential:
   The normal optic disc contains:
   - Nerve fibers (the neuroretinal rim, which is pink)
   - An area without nerve fibers (the optic disc cup, which is white)
   - Blood vessels.

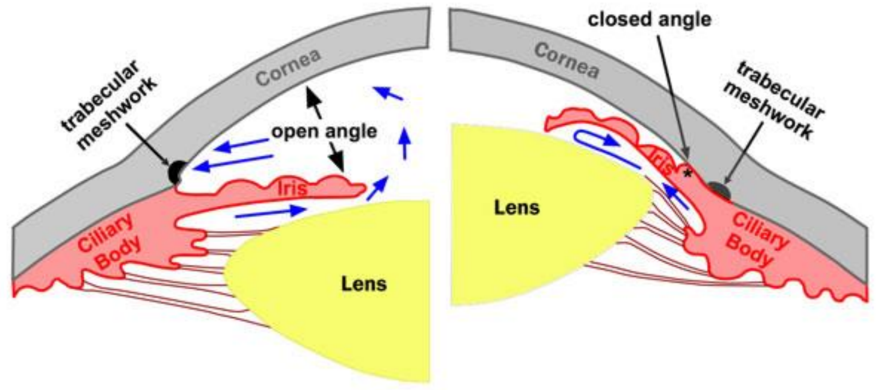
As nerve fibers are damaged and lost, the proportion of pink neuroretinal rim diminishes, the rim becomes pale and the cup enlarges.

3. Examine the iridocorneal angle with the gonioscopy lens to confirm that an open angle is present.

Management:

1. Lowering of the IOP by suppression of the aqueous humour formation (drops and tablets)
2. Increase in aqueous outflow (drops, drainage surgery)

Angle closure glaucoma



- Typically primary.

Clinical features:

1. Pain, nausea, vomiting
2. Loss of vision
3. Haloes
4. Red eye (usually unilateral)
5. Cloudy cornea (caused by corneal edema)
6. Oval, nonreactive pupil
7. Los of red reflex.

Management:

1. Treat the elevated IOP urgently, with topical and systemic aqueous suppressants (beta-blockers and acetazolamide)
2. The pupil block can be reversed by pilocarpine.
3. Systemic administration of analgesics and anti-emetics is welcome to the patient.
4. Once the acute attack has resolved, treatment to prevent recurrence and to prevent involvement of the at-risk fellow eye must be undertaken. this requires a laser iridotomy, which allows aqueous humour to pass from the posterior to the anterior chamber, by passing the pupil.

Congenital glaucoma

- Present at birth, in infancy or even in childhood.
- Primary congenital glaucoma caused by abnormal development of the anterior chamber angle.
- Secondary congenital glaucoma are uncommon.

Clinical features:

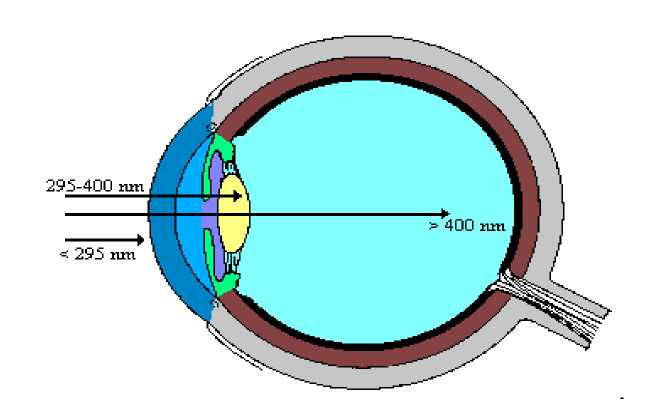
- The infant eyeball unlike adults can enlarge with elevation of IOP (buphthalmos) (ox eye)
- The cornea becomes hazy
- The eye waters

Treatment:

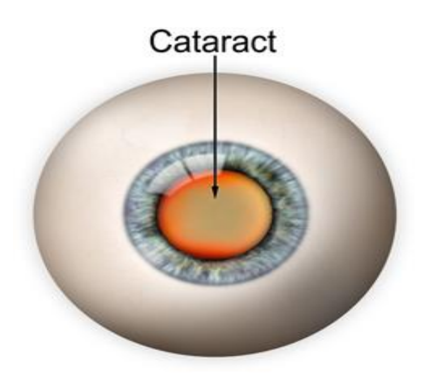
Surgery but often fails.



Lens disorders



Cataract



Definition:

Opacity of the lens of the eye, which is the commonest cause of treatable blindness in the world.

Etiology:

1. Normal age related degenerative changes.
2. UV light
3. No apparent cause.
4. Hereditary
5. Systemic syndrome
6. Infection
7. Systemic drugs
8. Diabetes
9. Ocular drugs (steroids)

Signs and Symptoms:

1. Painless loss of vision.
2. Glare

3. Change in refractive error
4. In infants, cause amblyopia
5. In some cases the acuity measured in dark room may seem satisfactory, where as if the same test is carried out in bright light the acuity will be seen to fall as a result of glare and loss of contrast.
6. The cataract appears black against the red reflex when the eye is examined with a direct ophthalmoscope.
7. Monocular diplopia
8. Leukocoria

Treatment:

1. treat amblyopia if found
2. surgery

Indications for surgery:

1. improve visual function (depends on the degree of impairment and the visual needs)
2. diabetic retinopathy (when cataract prevent adequate retinal examination or laser treatment)

Complications of cataract surgery:

1. vitreous loss
2. iris prolapsed
3. endophthalmitis
4. postoperative astigmatism
5. cystoids macular edema
6. retinal detachment

7. opacity of the posterior capsule
8. if the fine nylon sutures are not removed after surgery they may break in the following months or years causing irritation or infection.

CHAPTER THREE

Diagnostic Drugs

Classification of ophthalmic drugs:

1. Cycloplegics
2. Mydriatics
3. Miotics
4. Local anaesthetics
5. Stains

Ideal properties of diagnostic drugs:

1. Should be available.
2. Should produce the desired depth of effect.
3. Should be fast in onset.
4. Should be short in duration.
5. Should have no unwanted pharmacological effects.
6. Should have no local or systemic toxic effect.
7. Should be easy to use.
8. Should be Stable

CYCLOPLEGICS

Cycloplegics are drugs that paralyse the ciliary muscle by blocking the muscarinic receptors normally stimulated by the release of acetylcholine from the nerve endings of the parasympathetic system.

Indication for cycloplegic examination:

1. In children with constant or intermittent esotropia.
2. In children and young adults with asthenopia and esophoria.
3. When the Retinoscopy findings differ significantly from the results of subjective refraction.
4. In cases of anomalies of accommodation
5. In cases where Retinoscopy along the visual axis is very difficult due to lack of patient co-operation or mental handicap.

Precycloplegic examination:

1. Case history.
2. Manifest refraction
3. Vision and visual acuity at distance and near.
4. Binocular status.
5. External eye examination.
6. Internal ocular examination.
7. Test of accommodative functions.

Official name	***Strength % w/v***	***Cycloplegic onset***	***Cycloplegic duration***	***Residual accomm.***	***Adverse effect***
Atropine sulphate	1.0	36 h	7-10 days	Nil	Allergic reactions, general CNS side effects
Cyclopentolate hydrochloride	0.5	60 min	24 h	1.00 D	Hallucinations CNS side effects
Homatropine hydrobromide	1.0	90 min	24 h	1.00 D	As for atropine
tropicamide	1.0	30 min	6 h	2.00 D	Occasional hallucinations

MYDRIATICS

Mydriatics are drugs which dilate the pupil to facilitate a more thorough examination of the fundus, lens periphery and vitreous.

Indications for Mydriatics examination:

1. Recent onset of floating opacities in the vitreous.
2. A relatively sudden decrease in visual acuity.
3. Unexplained loss of visual field
4. Unexplained ocular pain.
5. Redness of the eye.
6. Cloudiness of the vitreous or lens.
7. Annual examination of the diabetic patient.

Contraindications:

1. The known presence of glaucoma.
2. The presence of an abnormality shallow anterior chamber.

Official name	***Strength % w/v***	***Mydriatics onset***	***Mydriatics duration***	***Reversed by***	***Adverse reaction***
Atropine sulphate	1.0	40 min	7 days	Ecothiopate	Allergic reactions, CNS toxic effects
Homatropine hydrobromide	1.0 2.0	40 min	48 h	Physostigmine	As for atropine
Cyclopentolate	0.1 0.5 1.0	30 min	24 h	Physostigmine	CNS effects
Tropicamide	0.5 1.0	15 min	8-9 h	Physostigmine	Some CNS effects
Phenyl-ephedrine	2.5 10.0	30 min	12-24 h	Pilocarpine	Systemic hypertension

Miotics

Miotics are drugs which constrict the pupil.

Ideal properties:

1. Quick in onset
2. A length of action appropriate to the mydriatic previously employed
3. An effect on the ciliary muscle which leaves the patient without cycloplegia or cyclospasm
4. An effect on the iris which allows a normal pupil light reflex
5. No other pharmacological effect
6. No local or systemic toxic effect
7. No adverse subjective complaints

Advantages:

1. Reduces the danger of angle closure glaucoma
2. Avoid photophobia
3. Speeds the return of accommodation if the mydriatic has a cycloplegic action
4. Lowers the intraocular pressure

Disadvantages:

1. The small pupil can lead to dimness of vision.
2. A spasm of accommodation may be caused, leading to pseudomyopia

STAINS

Official name	***strengths***	***uses***	***Adverse reaction***
Fluorescein sodium	1.0-2.0	Tonometry, corneal abrasions, contact lens fitting	Supports growth of pseudomonas aeruginosa
Rose Bengal	1.0	Stains dead cells, diagnosis of dry eye	Irritant on application to dry eyes
Alcian blue	1.0	Stains mucus	Persistent staining of corneal epithelium
Trypan blue	1.0	Stains mucus and dead cells	-

Ideal properties:

1. They should be water soluble.
2. Should selectively stain certain cells or structures in the eye.
3. Should not stain skin, clothes, and contact lenses.
4. The effect should be reversible.
5. Should be no other pharmacological effect.
6. Should be non-irritant to the surface of the eye.
7. Should be nontoxic.

Local anaesthetics

Are chemical agents that reversibly block the transmission of nerve impulses along sensory fibers.

Official name	Alternative name	Strength	Onset	Duration
Amethocaine	Tetracaine	0.5 1.0	1 min	20 min
Benoxinate	Oxybuprocaine	0.4	1 min	15 min
Proxymetacaine	Proparacaine	0.5	1 min	15 min
Lignocaine	Lidocaine	2.0 to 4.0	1 min	30 min

Ideal properties:

1. Quick in onset
2. Be effective for a reasonable duration of time
3. Not affect the pupil.
4. Not antagonize or enhance the effects of other drugs
5. Nontoxic
6. Have no adverse subjective complaints

Indication for use:

1. Foreign body removal
2. Tonometry
3. Contact lens fitting
4. Schirmer test
5. Gonioscopy

CHAPTER Four

ophthalmic instruments

Retinoscopy



Introduction:

Optometry is a unique profession. One thing that makes us unique is how we use light to gain insights into both the potential and actual behaviors of a human being eye.

A number of techniques for using a retinoscope have been developed. Each of these seems to be associated with different optometric pioneer who had on idea that helped to bring that use of the retinoscope to the fore. It is important to note that none of these techniques is thought to be better or worse than another, each is used to answer slightly different questions about the patient's potential and actual behaviors.

Retinoscopy:

It is an objective (don't depend on input from the patient) method of analyzing the optics of the patient's eye to determine the patient refractive error.

We use the retinoscope to illuminate the inside of the patient's eye and to observe the light rays as they emerge from the patient's eye.

The key light rays in retinoscopy are reflected from the external limiting membrane.

Retinoscope principles:

The retinoscope projects a beam of light into the pupil of the patient's eye.

Through the peep-hole the observer sees a light reflex coming from the patient's pupil.

By observing the behavior of the reflex under certain conditions, the observer can determine the refractive error of the patient's eye.

Types of Retinoscope:

1. Spot retinoscope.
2. Streak retinoscope ⇨ more accurate than the spot retinoscope and easier to learn, more useful to examine astigmatic eye.

Static vs. dynamic:

- Static ⇨ retinoscopy is performed with the patient fixating a target at infinity or with accommodation relaxed (far).
- Dynamic ⇨ retinoscopy is performed with patient fixating a near target, presumably, the patient is accommodation during retinoscopy (near).

Optics of the retinoscope:

Systems of the retinoscope:

1. Illumination system
    - Source (s).
    - High plus condensing lens inside the retinoscope.
    - Sleeve (more the condensing lens up and down).
    - Plane mirror (to redirect the light from it's source inside the retinoscope towards the patient's eye).
    - Apparent source (s'): the image of the real source.
2. Observation system.

✓ **How does manual retinoscopy compare to auto-refractors results?**

Auto-refraction can be "fooled" by irregularities (e.g corneal edema cataract) in the ocular media. The advantage of manual retinoscopy is that you can "see" the media irregularities (by the behavior of the reflex) and the refraction.

Using the retinoscope:

- Hold the Retinoscope in one hand so that you can view the patient's eye through the peephole of the scope. Depending upon the model, your thumb or index figure of the same hand is used to hold the sleeve in the sleeve-up/down position and to rotate the sleeve which rotates the streak.
  Add working distance lens: for 67 cm we add +1.50 sph, for 0.5 m we add +2.00 D sph.
- When the streak is oriented on 90 degree, it is being moved on 180 degree (streaking 180°).
- When the streak is oriented on 180 degrees, it is being moved on 90 degree (streaking 90°)

- We are using the widest possible streak.
- As you move the streak across the pupil, there are three basic types of reflexes that will be seen:

1. With motion.
2. Against motion.
3. Neutral motion.

With motion: as the streak moves across the pupil, the reflex moves across pupil in the same direction as the streak. (corrected with + lens).

Against motion: as he streak moves across the pupil, the reflex moves in the opposite direction as the streak. (corrected with - lens).

Neutral reflex (no motion): once the streak touches the pupil, the pupil lights up and remains constant as the streak moves across the pupil.

- Scope the four primary retinoscopy meridians (90, 180, 45, 135) by moving the streak along each of these meridians. Although the meridians of any astigmatism present may not fall exactly on one of the primary meridians, we will be able to detect any astigmatism present by streaking these primary meridians.

Practical example:

We being streaking the patient eye and notice that there is a reflex that shows against-motion in all meridians ⇨ the rule is that we add minus sphere power until we see natural reflex in all meridians (or with motion).

Subtracting the working distance:

(If we didn't add WDL)

As we were working on 67 cm, so there is a need to subtract about 1.50 D lens from the gross retinoscopy result.

Example:

The patient gross retinoscopy result is – 5.00 D, calculate the net retinoscopy result.

-5.00 -1.50 -6.50 D.

Streak reflex width and streak speed:

- In general, the width of the streak reflex and the apparent speed of the streak reflex as it moves across the pupil give an indication of how far you are from neutrality.
- Young eyes that are not diseased and have not had surgery give the most defined reflexes. Corneal diseased, cataract, IOL's, hazy posterior capsules, and cloudiness in the vitreous distort the reflexes and change the "rules" of appearance.
- Sometimes width and speed do not give reliable clues and you must just rely on apparent with-motion to arrive at the best retinoscopic estimate.

Example:

A very wide, slow moving streak reflex indicates that you are a long way from neutrality.

In with reflex, as we add plus sphere power the streak tends to narrow and speed up in its apparent motion.

At neutrality the streak reflex widens more to completely fill the pupil.

The skew phenomenon:

If we streak a meridian that is away from the meridian of the correct axis the streak reflex will tend to travel along the correct meridian rather than follow the streak. This guides us back to the correct meridian.

Keratometry



Introduction:

The curvature of the front surface of the cornea varies from patient to patient. A keratometer is used to measure the radius of curvature on the front surface of the cornea.

The term keratometry and ophthalmometry have been used to describe this process, but since only the curvature of the anterior surface of the cornea is being measured, the most appropriate term is keratometry.

Clinical use:

1. Keratometry can access the curvature, diopteric power and toricity (astigmatism).
2. Keratometry can also assess the integrity of the cornea and tear film over the eye.

(On a healthy cornea, the keratometer mires will appear clear and regular in shape. An abnormal tear film or irregularly shaped cornea will have irregular looking mires).

3. Keratometry can determine the contact lenses Base Curve (B.C).
4. In intra ocular lens (IOL) power calculating prior to lens implantation.

Instrumentation:

There are two main available types of keratometer, but both measures the radius of curvature of the central zone of the cornea, approximately 3 mm in diameter.

The radius of curvature of the axial zone of the emmetropic eye is about 7.8 mm. The optical power of the cornea can also be expressed in diopters.

However for most corneas an approximation is provided by the keratometer equation on which the refraction index of tears (1.336) is standardized to (1.3375) so that the radius of curvature of 7.8 mm corresponds to 45 D

$$\mathbf{D = n2\text{-}n1/r = 1.3375\text{-}1/0.0078 = +43.27}$$

The central cornea is assumed to be a spherical refracting surface but the more peripheral corneal cornea is flatter and non-spherical.

Corneal shape:

The average anterior and posterior corneal power is 48.6 D. To simplify it in clinical practice or in keratometry, a substitution with one refractive surface with the resulting corneal power of 42-44 keratometric diopters is often used. The average cornea changes little with age. It flattens about 0.5 D by age 30 and steepens about 1 D by age 70 yrs.

During adulthood an average cornea is steeper in the vertical meridian by about 0.5 D compared to the horizontal meridian, which contributes to higher incidence of with the rule astigmatism in young adults.

The difference between vertical and horizontal curvature diminished with age, finally disappearing at age 70 yrs. Lenticular changes significantly to the higher incidence of against the rule astigmatism with age.

Normal cornea is prolate in shape i.e. steeper in the center and flatter in the periphery. Oblate surface is flatter in the center and steeper in the periphery (e.g. surface after myopic laser photo refractive keratometry).

The visually significant area of the corneal surface is approximately the area with the same diameter as the pupil size. The pupil diameter decreases with age.

The average central corneal thickness is approximately 550 μm.

Theory:

The optical principle on which the keratometer works is the relation-ship between the size of an object and the size of the image of that object. Reflected from a convex mirror.

Image size/Object size = image distance/object distance

In keratometry the distance between the object and the anterior surface of the cornea is relatively tong. So that the virtual image is located very close to the focal point of the cornea.

Therefore the image distance may be taken to equal **r/2,** where **r** is the radius of curvature of the reflecting surface.

Substituting in the above formula:

Image size/object size = r/2object distance

r = (2object distance × image size)/object size

The equation is known as the approximate keratometer equation.

The von Helmholtz keratometer has a fixed object size and the image size is adjusted to measure the corneal curvature, while in Javal schoitz instrument the object size is varied to achieve a standard image size.

In order to study closely and measure the image formed by reflection at the cornea, some means must be adopted to overcome the natural movement at the patient's eye. Even small movements of the eye can cause the image to dance about. Thus difficulty has been over come by moves, both images move together and reading can be made by aligning the images one with other.

Doubling principle:

A prism is introduced into the optical system so that the two images of the object are produced. Both of these images will move the same amount of the eye moves. The prism can then be moved along the optical axis until the two images are just touching. At this point the prismatic displacement is exactly equal to the size of the image. The doubling principle is used in different instruments.

Taking keratometry readings:

1. focus the eyepiece
2. Make sure the patient is seated comfortable. Place chin in chin rest and have the patient hold head firmly against the head rest, adjust the chin rest to the appropriate level for the patient.
3. raise or lower the barrel to align the instrument with the patient's eye level
4. move the barrel to focus on the right eye
5. cover the left eye with the occluder
6. Look through the eyepiece and locate the mires.
7. place the black line in the center of the mires
8. When the mires are out of focus, they will appear distorted.
9. once the mires are focused, lock the instrument in place by tightening the locking knob.

10. Instruct the patient to blink normally. This provides an even tear film.
11. using rotating grip, turn the axis until the lines of the two mires be aligned. (this is the axis of the first reading)
12. turn the grip until the two mires touch each other. (this is the first K readings)
13. repeat step 11,12 to find the second reading.

Recordings:

Record as follow:

OD: 7.8 X 20 , 8.00 X 110

OS: 7.5 X 90 , 7.7 X 180

Corneal ast. Is the difference between the horizontal and vertical meridians:

OD= 7.8 – 8= -0.2 X steeper = -0.2 x 20

= -0.2 * 5 = -1.00 D x 20

OS = 7.5 – 7.7 = -0.2 X steeper = -0.2 X 90

=-0.2 * 5 = -1.00 D X 90

- radius of curvature ______ the lower number is the steeper
- diopteric power _______ the lower number is the flatter
- average of the diopteric power of the normal cornea is 42.00 to 44.00 D
- flat cornea < 42.00 D
- steep cornea > 44.00 D

Javal's rule:

Predicting total refractive ast. From corneal ast:

Total refractive ast. (TRA) = keratometry ast. (corneal ast.) * 1.25 + (-0.5 X90)

Example:

TRA = (-1.00 X 180) * 1.25 + (-0.5 X90)

= (-1.25 X 180) + (+0.5 X180) = -0.75 X 180

Extending the keratometer range:

Keratometer reads 36-52 D corneal curvature.

Increasing the range: +1.25 D lens add 9.00 D to range (45 – 61)

e.g. Read 50 D really 59 D

Decreasing the range: -1.00 D lens subtracts 6.00 D from range (30 – 46)

e.g. read 40 D, really 34 D

Converting radius of curvature into power:

What is the power of a cornea with a radius of curvature 7.8 mm?

D = (n2 – n1) / r

D = 43.25 D

Limitations:

There are limitations of keratometer of which must be aware:

1. The keratometer measures a small area of the cornea approximately 2.6 to 3.7 mm and thus doesn't give an accurate picture of the peripheral cornea.

2. the measurements obtained are taken along the visual axis rather than the geometric axis. The visual axis usually nasal compared with the geometric axis. Highly myopic corneas and highly ast. Corneas may yield incorrect values.

Distorted irregular mires:

Irregular corneal surface due to pathology (Keratoconus), corneal surgeries, sever tear film abnormalities.

Screening visual field

Confrontation test

Purpose:

To screen for previously unnoted visual field defects. This technique is generally effective only for substantial field losses.

Equipment:

- Overhead lamp.
- Target (white sphere, 3 mm or less in diameter, mounted on matte black wand).
- Occluder.

Set up:

- Instruct the patient to remove his glasses.
- The examiner faces the patient eye level, about 50 cm away.
- The space between the patient and the examiner should be brightly illuminated, but light should not shine directly into either the patient's or the examiner's eye.
- The rest of the testing room should be dimly illuminated.
- The patient holds the occluder.

Step by step procedure:

1. Hold a finger in front of the eye being tested at a distance of 40 to 60 cm. Instruct the patient to maintain fixation on the tip of your finger throughout the test.
2. Show the target to the patient.
3. Tell him that you are going to bring the target into his side vision. Instruct the patient to tell you as soon as he sees it. Repeat the instruction to keep looking at the top of your finger.
4. Instruct the patient to cover his left eye with the occluder.
5. Throughout the test, the target should remain 1 to 3 inches from the patient's facial structures.

6. Place the target where the patient can't see it; then slowly move it toward his line of sight, noting the location at which he first reports seeing it. Note that since the target is close to the patient's face, even small movements cover large angles and rapid movements will cover large angle quickly.
   Note: as you perform this test, try to visualize where the limits of the patient's field ought to be. In this test you are comparing where the patient sees the target to where, in your judgment, he ought to be able to see it.
7. Test the appropriate eight locations in the field, on each side of the four visual field meridian.
8. When you have mapped the field for the right eye, instruct the patient to occlude his right eye and repeat steps 6 and 7 on the left eye.
9. Throughout the test, monitor the patient's fixation and keep reminding him to maintain fixation on your fingertip.

Recording:

- Record the results for each eye separately.
- If the field is normal, write "full".
- If the field is abnormal, write "restricted" followed by the location of the restriction.

Ophthalmoscopy

Direct ophthalmoscope:



Is one of the instruments used to evaluate the health of the media (cornea, aqueous humour, lens, and vitreous humour) and the posterior pole of the patient's eye (fundus includes the retina, choroid, sclera, optic nerve and the central retinal artery and vein)

- Ophthalmoscopy is important in evaluating the general health of the patient as well as the health of the eye, because:
    1. The eye is the only place in the body where living blood vessels can be viewed without cutting into tissue.
    2. The optic nerve, a part of the brain, is also visible.

Advantages of direct ophthalmoscope:

1. Easy to learn
2. Can be done through an undilated pupil
3. Magnification is greater than with indirect ophthalmoscope

Disadvantages of direct ophthalmoscope:

1. Limited field of view
2. Monocular instrument

Magnification of the fundus using the direct ophthalmoscope comes from the power of the patient's eye:

M (magnification) = D (power of patient's eye) / 4

1. An emmetropic eye with total power of +60 D:
   M = 60/4 = 15 x
2. A 10 D myopic eye with total power of +70 D:
   M = 70/4 = 17.5 x
3. A 10 D hyperopic eye with total power of +50 D:
   M = 50/4 = 12.5 x

Procedure:

1. Switch on the ophthalmoscope: use only as much light as you need to see patient's eye.
2. Adjust the lens wheel: which is used to compensate for the patient's and doctor refractive errors.
   Should be set at +9.00 D to +12.00 D to start the exam
3. Set the aperture on the large or medium beam to start the routine exam.
   Switch to the small beam to examine the macula.
4. The patient should be at height comfortable for the examiner
5. Instruct the patient to remove his glasses
6. Instruct the patient to look on 20/400 E, keeping his/her accommodation relaxed.
7. To examine patient's OD, hold the ophthalmoscope in your right hand and use your right eye.
   To examine patient's OS, hold the ophthalmoscope in your left hand and use your left eye.
8. You will have to get close to the patient, so you should inform the patient that you will be getting close to his/her eye with the light.
9. 15^{o} temporal to the patient's line of sight will able you to test the optic disc.
   While being straight ahead will able you to test the macula.
10. Record what you have seen.

Recording:

- Media: clear or opacity (location of opacity)
- Disc margins: distinct, or any crescent
- Disc color: pink or white
- Macula: clear or describe what you see if not clear.
- Foveal reflex: + or –

Comparison between direct and indirect ophthalmoscope

	Direct ophthalmoscope	**Indirect ophthalmoscope**
Binocularity (stereopsis)	Monocular (absent)	Binocular (present)
Magnification	15 x	28-30 = 2 x 20 = 3 x 13 = 5 x
Field of view	Smaller	Larger
Image orientation	Inverted, real	Erect, virtual
Affecting by refractive error	Affected	Not affected
Learning techniques	No	Yes



Slit lamp (Biomicroscopy)



The purpose of Biomicroscopy:

To evaluate the health of the adnexa and anterior segment of the eye.

Uses:

1. Evaluation of lids, lashes, conjunctive, cornea, anterior chamber, iris, and lens.
2. Evaluation of contact lenses on the eye
3. Used in conjunction with auxiliary lenses to view the anterior chamber angle and the ocular fundus.

The slit lamp has some special functions which require the use of auxiliary lenses. These include:

1. Gonioscopy: examine the anterior chamber angle through a contact lens
2. Goldmann Tonometry: measurement of IOP.

3. Fundus evaluation: through a dilated pupil with a lens that is mounted on the slit lamp, held in front of the patient’s eye, some examples of these lenses:
   - Hruby lens (- 58 D)
   - Hand lens lenses (+90 D, +60 D, +78 D)
   - Goldmann 3-mirror fundus contact lens
4. Pachometry: measurement of the thickness of the cornea.
5. Photography: to take anterior segment photos or fundus photos.

Filters of slit lamp:

1. No filter is used for a routine slit lamp exam
2. The blue filter is used in conjunction with Fluorescein dye to view the tears and for Goldmann Tonometry
3. The green (or red free) filter: is used in fundus evaluation to differentiate blood from pigment in the fundus and to locate small hemorrhages.
4. The neutral density filter: used to decrease the light when the patient is particularly light sensitive.

Procedure:

1. Prepare the slit lamp for you:
   - Adjust table for comfortable for both the examiner and the patient
   - Set the reflecting mirror
   - Set the magnification on low
   - Adjust oculars and PD
   - Set up a diffuse beam with medium intensity
2. Prepare the patient:
   - Wipe the chinrest and forehead rest with an alcohol wipe.
   - Instruct the patient to put his chin in the chinrest and his forehead against the forehead rest.
   - Align the patient’s outer canthus with the marker on the upright support of the slit lamp.
   - Instruct the patient to close his eyes.
3. Examine the eyes:
   - From outside to inside

- Low to medium magnification

Ocular structure	**Type of slit lamp beam**	**Angle of illumination arm**	**Magnification**
Lid/lashes	Diffuse	30^o	Low
Conjunctiva	Wide parallelepiped (6-8 mm)	30^o	Low
Cornea	Narrow parallelepiped (1-3 mm)	$30\text{-}45^o$	Medium
Anterior chamber: -Angle depth -aqueous	 Optic section (less than 0.25mm Conical beam	 60^o 30^o	 Medium High
Iris	Wide parallelepiped	$30\text{-}45^o$	Medium
Lens	Narrow parallelepiped	$20\text{-}30^o$	medium

Tonometry



the intraocular pressure (IOP) is determined by the balance between aqueous humor production and drainage.

Intraocular pressure:

1. Low IOP < 7 mmHg
2. Normal IOP = 8-20 mmHg
3. High IOP > 21 mmHg

Tonometer:

Is an instrument used to measure the IOP.

Three common tonometers are:

1. Non-contact tonometer (NCT)
2. Goldmann tonometer
3. Schiotz tonometer

How to prepare patient for Tonometry:

1. If the patient wears contact lenses, remove them before the test, and don't put them back for 2 hours after the test.
2. Remove any tight clothing around patient's neck (pressure on the veins in neck can increase the pressure inside eyes)
3. Instruct the patient to:

- Keep relaxed.
- Not to drink more than 2 cup of fluid 4 hours before the test.
- Not to drink alcohol for 12 hours before the test.

NCT:

The air puff tonometer flattens the eye with a puff of air which doesn't require anesthetic.

Since the NCT works by flattening the cornea, it is considered to be an "applanation" tonometer.

The time required to flatten the cornea by a set amount corresponds to the IOP.

Procedure:

1. The NCT flattens the eye with a puff of air, which is rapid and innocuous enough so as not require the use of local anesthetic.
2. At the instant the air puff is launched, a timer is started.
3. The NCT also contains a light detector.
4. When the puff of air strikes the cornea, it begins to flatten it, when the cornea is flattened by a set amount, a specific quantity of light reaches the detector, and the clock stops.
5. The time required for the air puff to flatten the cornea by the set amount corresponds to the IOP.
   The cornea may flatten further, but the clock has already stopped.

Goldmann applanation Tonometry:

Today Goldmann Tonometry is the standard for IOP measurement.

- In Goldmann Tonometry, a flat polished probe, commonly mounted on the slit lamp is pushed against the patient's anesthetized cornea. The force with which the probe is pressed against the eye is varied until a predetermined amount of the cornea has been flattened. The force corresponds to the IOP.
  Fluorescein dye is instilled into the tear fluid and the slit lamp blue cobalt filter is used.

Schiotz indentation Tonometry:

1. Use anesthetic eye drops.
2. Instruct the patient to lie on his/her back and to look up at the spot on the ceiling.
3. Gently touch the tonometer to the patient's eye and hold it there for a few seconds to take the readings.

CHAPTER FIVE

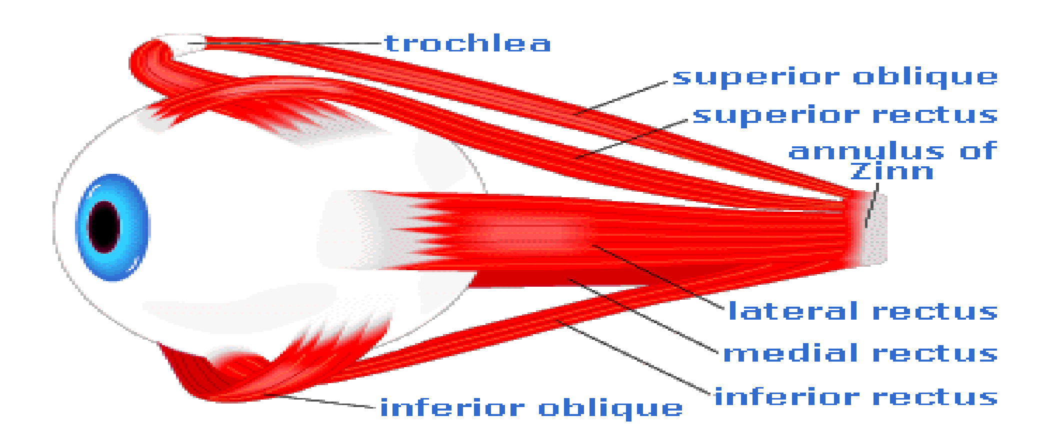
binocularity

Extraocular muscles (EOM)

Definition:

Are the six muscles that control the movements of the (human) eye.

- The actions of the Extraocular muscles depend on the position of the eye at the time of muscle contraction.
- the six Extraocular muscles, which act to turn or rotate an eye about its vertical, horizontal, and antero-posterior axes:
  1. **Medial rectus** (MR)
  2. **Lateral rectus** (LR)
  3. **Superior rectus** (SR)
  4. **Inferior rectus** (IR)
  5. **Superior oblique** (SO)
  6. **Inferior oblique** (IO)



Muscle movements:

- **medial rectus** (MR)
  - moves the eye inward, toward the nose (adduction)
- **lateral rectus** (LR)
  - moves the eye outward, away from the nose (abduction)
- **superior rectus** (SR)
  - primarily moves the eye upward (elevation)
  - secondarily rotates the top of the eye toward the nose (intorsion)
  - tertiarily moves the eye inward (adduction)
- **inferior rectus** (IR)
  - primarily moves the eye downward (depression)
  - secondarily rotates the top of the eye away from the nose (extorsion)
  - tertiarily moves the eye inward (adduction)
- **superior oblique** (SO)
  - primarily rotates the top of the eye toward the nose (intorsion)
  - secondarily moves the eye downward (depression)
  - tertiarily moves the eye outward (abduction)
- **inferior oblique** (IO)
  - primarily rotates the top of the eye away from the nose (extorsion)
  - secondarily moves the eye upward (elevation)
  - tertiarily moves the eye outward (abduction)

The primary muscle that moves an eye in a given direction is known as the "***agonist"***.

A muscle in the same eye that moves the eye in the same direction as the agonist is known as a "***synergist"***.

While the muscle in the same eye that moves the eye in the opposite direction of the agonist is the "***antagonist"***.

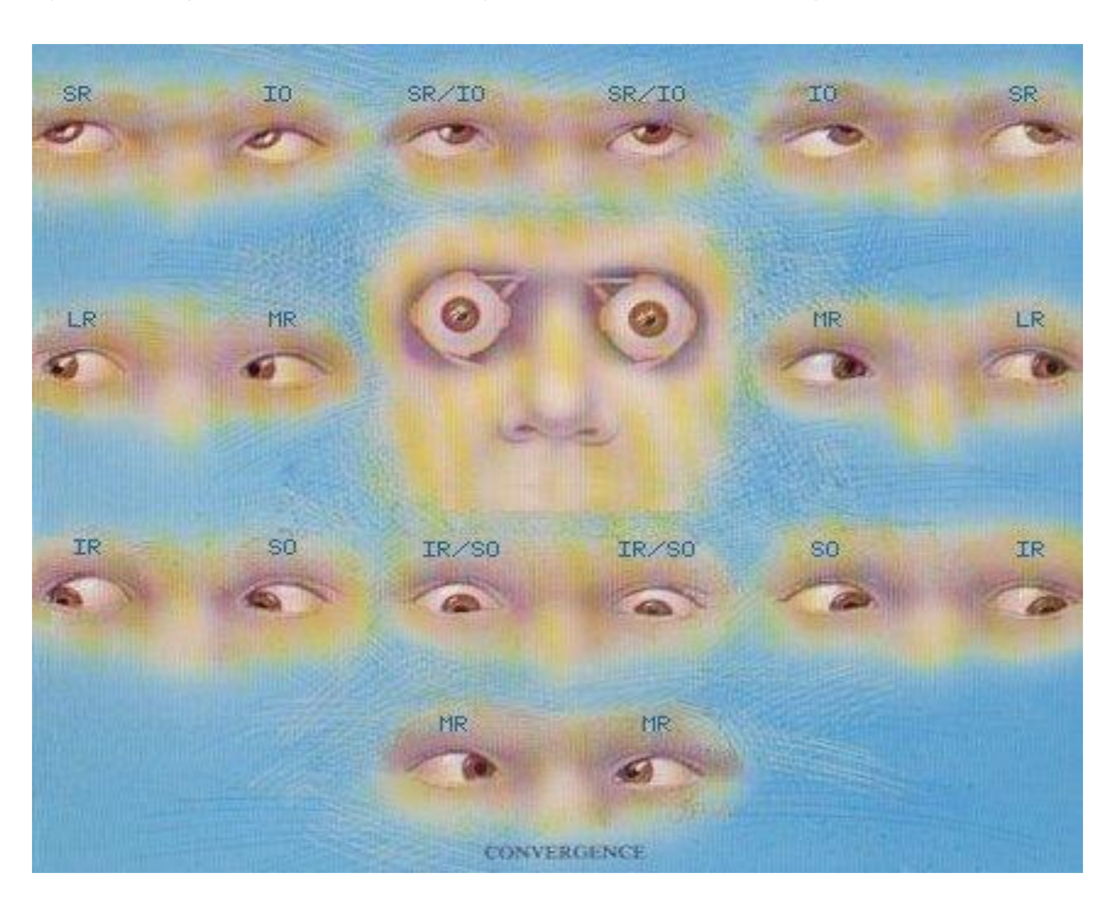
According to "Sherrington's Law," increased innervations to any agonist muscle are accompanied by a corresponding decrease in innervations to its antagonist muscle(s).

Cardinal positions of gaze

Are six positions of gaze which allow comparisons of the horizontal, vertical, and diagonal ocular movements produced by the six Extraocular muscles.

- up/right
- up/left
- right
- left
- down/right
- down/left

In each position of gaze, one muscle of each eye is the primary mover of that eye and is ***yoked*** to the primary mover of the other eye.



Muscle innervations

- **medial rectus** (MR)—cranial nerve **III** (Oculomotor)
- **lateral rectus** (LR)—cranial nerve **VI** (Abducens)
- **superior rectus** (SR)—cranial nerve **III** (Oculomotor)
- **inferior rectus** (IR)—cranial nerve **III** (Oculomotor)
- **superior oblique** (SO)—cranial nerve **IV** (Trochlear)
- **inferior oblique** (IO)—cranial nerve **III** (Oculomotor)

The following can be used to remember the cranial nerve innervations of the six Extraocular muscles:

$$\mathbf{LR_6\,(SO_4)_3}$$

That is, the lateral rectus (LR) is innervated by C.N. 6, the superior oblique (SO) is innervated by C.N. 4, and the four remaining muscles (MR, SR, IR, and IO) are innervated by C.N. 3.

Anatomical arrangement:

All of the Extraocular muscles, with the exception of the inferior oblique, form a “cone” within the bony orbit. The apex of this cone is located in the posterior aspect of the orbit, while the base of the cone is the attachment of the muscles around the midline of the eye.

The apex of the conic structure is a tendonous ring called the “annulus of Zinn.” Through the annulus, and along the middle of the cone of muscles, runs the ***optic nerve*** (cranial nerve II). Within the optic nerve are contained the ophthalmic artery and the ophthalmic vein.

The superior oblique, although part of the cone of muscles, differs from the other muscles in a significant way. Before it attaches to the eye, it passes through a ring-like tendon, “trochlea,” in the nasal portion of the orbit. The trochlea acts as a pulley for the superior oblique muscle.

The inferior oblique arises from the lacrimal fossa in the nasal portion of the bony orbit. This muscle attaches to the inferior portion of the eye.

Ductions:

When considering each eye separately, any movement is called a "Duction."

- Abduction: is a horizontal movement away from the nose, caused by a contraction of the LR muscle, with an equal relaxation of the MR muscle.
- Adduction: is a horizontal movement toward the nose, caused by a contraction of the MR muscle, with an equal relaxation of the LR muscle.
- Supraduction (elevation): is a vertical movement upward, caused by the contraction of the SR and IO muscles, with an equal relaxation of the of the IR and SO muscles.
- Infraduction (depression): is a vertical movement downward, caused by the contraction of the IR and SO muscles, with an equal relaxation of the SR and IO muscles.
- Incycloduction (intorsion): is an inward rotation (of the top of the eye), caused by the contraction of the SR and SO muscles, with an equal relaxation of the IR and IO muscles.
- Excycloduction (extorsion): is an outward rotation (of the top of the eye), caused by the contraction of the IR and IO muscles, with an equal relaxation of the SR and SO muscles.

Versions:

A "version" or "conjugate" movement involves simultaneous movement of both eyes in the same direction.

Agonist muscles in both eyes, which work together to move the eyes in the same direction, are said to be "yoked" together. According to "Herring's Law," yoked muscles receive equal and simultaneous innervations.

- **Dextroversion** (looking right)
    - right lateral rectus
    - left medial rectus

- **Levoversion** (looking left)
  - left lateral rectus
  - right medial rectus
- **Supraversion or sursumversion** (looking straight up)
  - right & left superior recti
  - right & left inferior obliques
- **Infraversion or deorsumversion** (looking straight down)
  - right & left inferior recti
  - right & left superior obliques
- **dextroelevation** (looking right and up)
  - right superior rectus
  - left inferior oblique
- **dextrodepression** (looking right and down)
  - right inferior rectus
  - left superior oblique
- **levoelevation** (looking left and up)
  - right inferior oblique
  - left superior rectus
- **levodepression** (looking left and down)
  - right superior oblique
  - left inferior rectus
- **dextrocycloversion** (rotation to the right)
  - right inferior rectus & inferior oblique
  - left superior rectus & superior oblique
- **levocycloversion** (rotation to the left)
  - left inferior rectus & inferior oblique
  - right superior rectus & superior oblique

Vergences:

A "vergence," or "disconjugate" movement, involves simultaneous movement of both eyes in opposite directions.

- **convergence**—both eyes moving nasally or inward
- **divergence**—both eyes moving temporally or outward

If one eye constantly is turned inward ("crossed-eye"), outward ("wall-eye"), upward, or downward, this is referred as a "strabismus" or "heterotropia," discussed later.

A vergence is performed relative to a point of fixation. For instance, someone could be looking at TV across the room (at a far distance). Then, when a commercial comes on, that person could converge both eyes to read a book (at a near distance). Then, after the commercial is over, both eyes would diverge to look at the TV again.

One cannot actually voluntarily diverge both eyes outward, at the same time, from looking straight ahead. That is, the two lateral recti muscles cannot pull the eyes outward, simultaneously and voluntarily, while one is viewing something far away. However, if one is falling asleep with one's eyes still open, it is possible for the eyes to diverge, momentarily and involuntarily, causing temporary diplopia (double vision).

Muscle	Innervation	Origin	Insertion	Primary function	Secondary function	Tertiary function
Superior rectus	Superior branch of Oculomotor nerve	Annulus of Zinn	eye (anterior, superior surface)	Elevation	Intorsion	Adduction
Inferior rectus	Inferior branch of Oculomotor nerve	Annulus of Zinn	eye (anterior, inferior surface)	Depression	Extorsion	Adduction
Lateral rectus	Abducens nerve	Annulus of Zinn	eye (anterior, lateral surface)	Abduction		
Medial rectus	Inferior branch of oculomotor nerve	Annulus of Zinn	eye (anterior, medial surface)	Adduction		
Superior oblique	Trochlear nerve	Annulus of Zinn	eye (posterior, superior, lateral surface)	Intorsion	Depression	Abduction
Inferior oblique	Inferior branch of oculomotor nerve	Maxillary bone	eye (posterior, inferior, lateral surface)	Extorsion	Elevation	Abduction

Strabismus

Strabismus (heterotropia):

When viewing an object, the "VISUAL AXIS" of both eyes intersect at the object, (both eyes point directly at the object being viewed). An image of the object is focused upon the ***macula*** of each eye, and the brain merges the two retinal images into one.

Sometimes, due to some type of Extraocular muscle imbalance, one eye is not aligned with the other eye, resulting in a "strabismus".

With strabismus, while one eye is fixating upon a particular object, the other eye is turned in another direction, relative to the first eye, whether inward ("cross-eyed"), outward ("wall-eyed"), upward, or downward. As a result, the person may experience "diplopia" (double vision), since two different objects are imaged onto the macula of both eyes. However, if the person's brain has learned to "suppress" the image of the strabismic eye, the brain will perceive only the single image from the other eye.

If the strabismus occurs sometimes, but not all of the time, it is said to be "intermittent."

If the strabismus occurs all of the time, it is said to be "constant."

If one eye will be the deviating eye at certain times, while the opposite eye will be the deviating eye at other times. That is, one eye will turn sometimes, but at other times the alternate eye will turn. This is referred to as "alternating" strabismus.

The deviant eye may be in any direction: inward ("esotropia" or "crossed-eye"), outward ("exotropia" or "wall-eye"), upward ("hypertropia"), downward ("hypotropia"), or any combination of these.

Strabismus also can occur due to a nerve paralysis or paresis, injury, or even due to a retinal disease. Sometimes a strabismus will result when there is a very different refractive error (usually much higher) in the strabismic eye compared to the other eye.

The angle of deviation of the strabismus is measured in "prism diopters." If the angle of deviation remains the same in all **cardinal positions of gaze**, the strabismus is classified as "concomitant" (or "nonparalytic"). If the angle of deviation is not the same in all cardinal positions of gaze, the strabismus is classified as "nonconcomitant" (or "paralytic").

OD (Right Eye) Esotropia



OD (Right Eye) Exotropia



<u>Esotropia:</u>

Congenital (a muscle imbalance present from birth), and usually the angle of deviation is large. Management involves surgical correction, typically at age six months or earlier.

Some cases of low-angle esotropia do not require surgery but, instead, respond successfully to visual therapy. This is true especially in a child or an adult for which the esotropia is of recent onset and for which there is no macular damage (that is, when the strabismic eye is capable of good visual acuity).

Accommodative, usually due to a high amount of uncorrected hyperopia (farsightedness). This causes a great deal of accommodation to be required to focus retinal images, resulting in a subsequent over-convergence (by the medial rectus muscles) and a subsequent esotropia.

The usual treatment for accommodative esotropia is eyeglasses or contact lenses, which compensate for the hyperopia, allowing the deviating eye to straighten.

Exotropia:

Congenital (very unusual). More commonly develops in infancy or in early childhood, often beginning as an intermittent strabismus and sometimes leading to a constant strabismus.

A carefully planned regimen of visual therapy often can be used to treat exotropia, especially in cases where complete suppression of the strabismic eye has not yet occurred and the eye is capable of good visual acuity.

In cases where visual therapy is not successful, surgical correction should be used to provide a cosmetically improved appearance of the deviating eye. This does not necessarily ensure that binocular vision will result.

Amblyopia and eccentric fixation:

If the vision in a strabismic eye is suppressed for too long, that eye very well may develop "Amblyopia" or a "lazy eye" condition.

This means that the ***visual acuity*** in that eye no longer is as good as the visual acuity in the other eye, which is used all the time.

When the normal eye is covered, thus forcing the strabismic eye to take over, the strabismic eye usually does not point exactly straight at the object being fixated. Therefore, the image of the object being viewed does not fall directly upon the ***macula***, as it should. Rather, the image falls upon some ***eccentric*** point, away from the macula, where the acuity is not as good. Thus, this is referred to as "eccentric fixation."

An eye is ***not*** a "lazy eye" simply because it turns and does not align with the other eye. Amblyopia ("lazy eye") simply refers to decreased visual acuity in one eye, compared to the other eye. That is, an eye is referred to as

“lazy” because it does not see as clearly as the other eye. The most common reason for Amblyopia is the presence of eccentric fixation in a strabismic eye.

Acquired muscle palsy:

Damage to cranial nerve III, IV, or VI often will cause a “palsy” (paralysis or paresis) of the Extraocular muscle(s) innervated by that nerve. The cause of the palsy usually is acquired (due to a lesion, a stroke, or other trauma), although occasionally it can be congenital (at birth).

An Extraocular palsy may cause the eyes to be misaligned, which is a ***strabismus***. The most common symptom of muscle palsy is diplopia (double vision)—that is, seeing two images either side-by-side, one on top of the other, or displaced diagonally.

When the Oculomotor nerve (cranial nerve III) is damaged, a palsy in the medial rectus, superior rectus, inferior rectus, and/or inferior oblique muscle(s) may occur. If all of these muscles are affected, the effected eye will be turned outward and downward (due to unopposed action of the lateral rectus and superior oblique muscles). The affected eye cannot turn inward past the midline, nor can it turn upward past the midline.

In a complete cranial nerve III paralysis, the upper eyelid also will be nearly closed from a ptosis. The pupil might be dilated and unreactive as well.

When the Trochlear nerve (cranial nerve IV) is damaged, a palsy of the superior oblique muscle may occur, resulting in a hypertropia of the affected eye. People with this condition will experience both a vertical and a torsional diplopia, and they will compensate for this by tilting the head toward the shoulder of the unaffected eye.

When utilizing the Bielschowsky head-tilt test, the person is told to tilt his/her head toward the shoulder of the affected eye. An overaction of the

inferior oblique, and an elevation of the affected eye (and marked diplopia), will result.

When the Abducens nerve (cranial nerve VI) is damaged, a palsy of the lateral rectus (LR) muscle may occur, resulting in an esotropia of the affected eye. That eye generally will not be able to look outward past the midline, and it will be somewhat turned inward when the other eye is fixating straight ahead. Diplopia will be observed by the person when he/she gazes to the side with the palsied muscle, and the person will compensate for this by turning his/her face toward the side of the palsied eye.

Extraocular muscle palsy may resolve on its own with time; however, this may not occur. If the palsy and resultant diplopia are permanent, a prismatic correction may be incorporated into spectacle lenses to merge the double images into a single image. Some people prefer simply to keep one eye patched to take away their double vision.

In some cases, muscle surgery is another option. However, it should not be performed for at least six months after the onset of diplopia, since the effects of the palsy may resolve spontaneously over a few weeks or months. If a ptosis (drooping upper eyelid) is involved, such as in a cranial nerve III paralysis, probably the best option is surgical elevation of the eyelid.

Functional vision entrance test

Functional vision:

The use of the eyes comfortably, how the two eyes function together as a single unit.

Functional vision testing:

Evaluate the patient’s ability to focus and coordinate his two eyes. These are the patient’s accommodative and binocular skills.

Binocular:

The use of both eyes simultaneously in such a manner that each retinal image contributes to the final percept.

Fusion:

Blending or uniting two elements.

Patient must have two types of fusion which we test during the functional entrance test:

1. ***Sensory fusion:***
   The ability to combine two images in to one (form,color, movement,and spatial relationship)
   The test are stereopsis and the Worth 4 Dot.
2. ***Motor fusion:***
   The ability to align the two eyes and to maintain alignment by EOMs. The tests are the Hirschberg test, the krimsky test, the cover test and the near point of convergence (NPC)

Sensory and motor fusion (normally) occur simultaneously. We measure the two functions separately.

Sensory and motor fusion are related to one another in the following way:

- Motor fusion doesn’t take place unless there is sensory fusion.

- Sensory fusion can't take place without motor fusion.

These function develop at about the same time in infant (3 to 6 months old).

The advantages of being binocular:

1. Having two eyes gives us a spare eye if one becomes non-functional due to disease or trauma.
2. Better fine motor coordination, and better perception of three-dimensional space (stereopsis).

Binocular field:

The area which gives sensory input to both the right and the left eyes.

Any object in the binocular field is imaged on both the retina of the right eye and the retina of the left eye.

The binocular field is the area where we have the best fine motor coordination and is the area that gives us the perception of depth (stereopsis).

The size of the monocular field on the temporal side of each eye (which is imaged on the nasal retina) varies with the size of nose.

The cues of depth:

1. ***Binocular:*** learned very early in life (4-6 months).
2. ***Monocular:*** learned later in life.

-We use monocular cues to depth when viewing far distance, binocular cues used for close distance.

-In some patients there is no potential to learn stereopsis, these patients use monocular cues to depth perception.

Monocular cues to depth:

1. ***Relative Size:*** larger object is closer and the smaller object is farther away.

2. ***Linear perspective:*** the lines at the top of the picture produce a smaller retinal image sizes, they are perceived as farther away.
3. ***Texture:*** shows that the smaller, more densely objects appear farther away than the larger, less densely objects.
4. ***Interposition:*** occurs when one object blocks the view of another object, so the blocked object appears farther away.
5. ***Lighting and shadow:*** when light falls on an object, the object casts a shadow. The shadow is behind the object.
6. ***Motion parallax:*** is a kinetic monocular depth. The apparent change in the position of an object resulting from a change in the viewer's position.
7. ***Accommodation:*** during accommodation, the diopteric power of the lens increases. This allows near objects to be clearly focused on the retina.

In order for sensory and motor fusion to occur, the following pre-requisities for binocularity must exist:

1. The patient must have two eyes that function normally and equally.
2. The retinal image to the right and left eye must agree in size, illuminance and color (for sensory fusion to take place).
3. The eyes must be capable of aligning themselves (for motor fusion to take place)

The test of sensory and motor fusion rely on some characteristics of the eyes:

- Local sign.
- Principal visual direction.
- Corresponding point.
- Physiological diplopia.

Local sign:

Is a characteristic of the sensory system which tells us where things are located in space relative to one another and to ourselves.

Local sign is a cortical phenomenon not a retinal phenomenon.

Principal visual direction:

In the normal eye, the local sign of the fovea correspond to straight ahead. This is known as the principal visual direction. All other objects in space are located relative to the principal visual direction.

If we are looking at something, we are using the fovea to fixate on it. Object in space located nasally to the fixated object are imaged on the temporal retina.

Object in space located above the fixated object are imaged on the inferior retina, and back wards.

Corresponding point:

Each pair of point, one in each retina, having the same visual direction and sending their nerve impulses to the same point in the visual cortex, giving rise to sensory fusion.

Objects in the right visual field go to the left visual cortex, and object in the left visual field go to the right visual cortex.

Objects that are imaged on corresponding points are seen singly if the observer has normal sensory fusion.

Stimulation of non-corresponding points is known as retinal disparity.

Large amount of retinal disparity results in diplopia.

Small amount of retinal disparity results in three dimensional binocular vision.

Physiological diplopia:

All points in object space that form pairs of non-corresponding retinal points and will give rise to double vision. This type of double vision is normal.

<u>Horopter:</u>

The location in object space of all points that form pairs of corresponding retinal points can be mapped as a solid surface known as the **Horopter.**

The Horopter is a solid not just a line. This is due to the fact that there doesn't have to be a point-by-point matching for retinal correspondence to occur.

<u>Panum's area:</u>

An area on one eye's retina that, when stimulated with a given single point in the other eye, will produce a single binocular percept.

(in other words, instead of a point-by-point correspondence between points in the two eyes, there is a point-to-area correspondence).

<u>Notes:</u>

- Points on the Horopter stimulate corresponding retinal points (within Panum's areas) and are seen singly.
- Points off the Horopter stimulate non-corresponding retinal points (not within panum's area) and are seen double. (physiological diplopia)
- The Horopter can be mapped for each person for a given fixation distance.
- The Horopter moves with the eyes and changes when the fixation distance changes.
- The Horopter is not a line, but an area; when looking at an object at a given fixation distance, there are things closer to you than that object and things further away from you than that object that are also seen as single because they are within the area of the Horopter. Objects outside the Horopter for a given fixation distance are seen as double (this is called **physiological diplopia**).

Sensory and motor fusion

Sensory fusion

Definition:

The ability to combine images from the right eye and the left eye into a single percept.

We routinely test sensory fusion during the functional entrance tests with a test of stereopsis and the Worth 4 Dot when stereopsis is abnormal.

Types of sensory fusion:

1. Simultaneous perception.
2. Superimposition (1st degree fusion).
3. Flat fusion (2nd degree fusion).
4. Stereopsis (3rd degree fusion)

Patient with normal binocularity have all four types of sensory fusion, but patients with abnormal binocularity have same types but not all.

During a routine exam, if the patient’s stereopsis is abnormal, we also test for flat fusion with the Worth 4 Dot.

The other types of fusion, superimposition and simultaneous perception are only tested during a specialized binocular work up.

<u>Simultaneous perception:</u>

Is not really fusion at all. It is simply being able to see something with each eye at the same time.

Simultaneous perception is tested by placing an image in the right eye and a different image in the left eye (using a stereoscope) and asking the patient if he can see both images at the same time.

Superimposition:

In addition to being able to see an object with the right eye at the same time as seeing a different object with the left eye, the patient is able to localize the two images in the same location at the same time.

When an image is placed in the right eye and on the corresponding points in the left eye (by an instrument called a stereoscope) the patient is able to see both of the images located in the same place.

Flat fusion:

The images to each eye have some similar detail and some non-similar detail but no perception of depth. The fused image sees all of the details that each eye sees separately.

The Worth 4 Dot is a test of flat fusion.

Stereopsis:

Is the perception of depth that is produced by binocular disparity.

It is important for providing finely tuned depth perception at near distances (particularly within arm’s length), especially when other depth cues are absent.

Stereopsis is less important when viewing objects at far distance.

Motor fusion

Definition:

The ability to align the two eyes and to maintain the alignment of the two eyes.

Tests of motor fusion:

1. Hirschberg test / krimsky test.
2. Cover test.
3. Near point of convergence (NPC).

During test of motor fusion, we find out:

- If the visual axis of the two eyes are aligned or not.
- If the patient is binocular.
- If the patient is capable of sensory fusion.

The position of the visual axis depends on two factors:

1. Tonic vergence.
2. Fusional vergence.

Vergence: a movement of the visual axis of the two eyes toward one another or away from one another.

Tonic vergence:

Is the continuous vergence response maintained by the EOMs tones.

- The ***right amount*** of tonic vergence will leave the two eyes parallel to one another ; this is called ‘’ **ortho** ‘’.
- ***Not enough*** tonic vergence will leave the eyes ***out*** relative to one another; this is called ‘’**Exo**’’.
- ***Too much*** tonic vergence will leave the eyes ***in*** relative to one another; this is called ‘’**Eso**’’.

Fusional vergence:

An eye movement that occurs in response to retinal disparity or stimulation of non-corresponding point.

- Fusional vergence align the two visual axis with one another and keeps them there.
- A patient who has an Exo or Eso posture as a result of tonic vergence, but who has a supply of Fusional vergence will be able to align his two eyes and has motor fusion. This type of patients has a **phoria.**
- Patient with an Exo or Eso who don't have an adequate supply of Fusional vergence will not be binocular; they will have **strabismus.**

Phoria:

A misalignment that is corrected by Fusional (disparity) vergence.

Strabismus:

The condition in which binocular fixation is not present under normal seeing conditions.

Other names of strabismus:

1. Tropia.
2. Squint.
3. Eye turn.

When the two eyes are not aligned, the image of the object of fixation fall on non-corresponding points. The result is **diplopia** unless the patient makes a sensory adaptation (such as suppression) to avoid diplopia.

Patient who has strabismus don't have motor fusion; they don't have Fusional vergence to overcome the excess or deficit of tonic vergence. This type of patient unable to align his two eyes and is not binocular.

STEREOPSIS

Stereopsis test:

This test helps the examiner evaluate the quality of the patient's depth perception.

Purpose:

To measure a patient's depth perception through his ability to fuse stereoscopic targets.

Stereo butterfly test



Equipment:

1. Polaroid glasses.
2. Stereotest booklet

Set up:

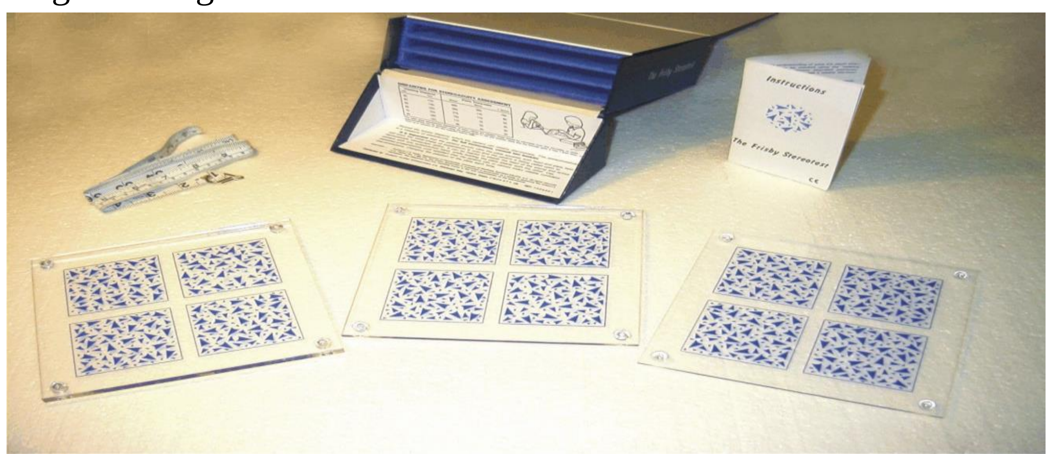
- The patient wears Polaroid glasses over his near correction.
- The patient holds the stereo target at 40 cm.
- The overhead lamp is directed toward the target.

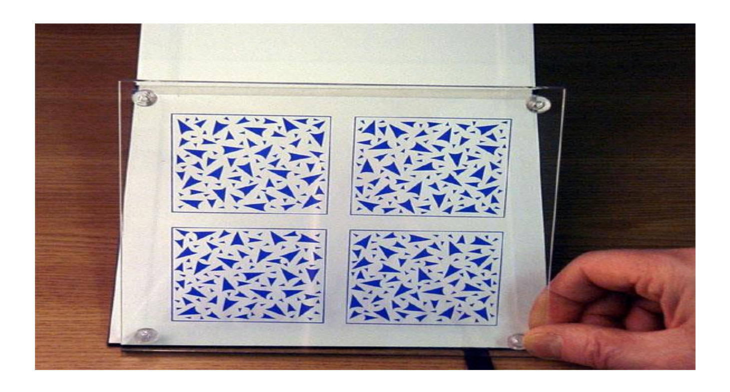
Step by step procedure:

While wearing special polarized glasses, the patient looks at a series of 3-D objects that range from being very raised to nearly flat. In each series, the patient is asked to select the object with the greatest 3-D effect.

The Frisby Stereotest

These are used chiefly in examining young children who will not tolerate wearing the test glasses.





It has three transparent plates. One of these is shown on each presentation to the subject.

On the other side of each plate is printed a background of similar texture. An observer with normal binocular stereovision can readily detect the target because it appears to stand out from the background.

An observer lacking normal binocular stereovision fails to be able to detect the target as it can be distinguished only on the basis of binocular disparity cues to depth.

The three plates are of differing thickness, 6mm, 3mm and 1.5mm. Thus they present different sizes of disparity cues, thereby enabling the stereoacuity of the observer to be measured.

Worth 4 dot test

Purpose:

- To assess the patient's flat fusion ability at distance and at near.
- The hand held worth 4 dot flashlight is also used to detect a small unilateral central scotoma.

Indications:

- The worth 4 dot is indicated when stereopsis is below 40 second of arc.
- It is also used in the differential diagnosis of unilateral decrease visual acuity.

Equipment:

1. Worth 4 dot target.
2. Red-green glasses.

Set-up:

1. The patient wears his habitual correction for the distance being tested.
2. The patient wears the red-green glasses over his correction, with the red lens over the right eye and the green lens over his left eye.
3. The examiner turns on the worth 4 dot box mounted at the end of the examination room for distance testing.
4. The held worth 4 dot flashlight is used for near testing and for testing for central suppression scotoma, and held at 16 in.

To test the patient's flat fusion ability at distance or at near:

1. Show the patient the worth 4 dot target with the white dot at the bottom and the red dot at the top.
2. Ask the patient how many spots of light he see?
   a. If he sees ***4*** dots, he has normal flat fusion.
   b. If he sees only ***2 red dots,*** he is using the right eye and suppresses the left eye.
   c. If he sees ***3 green dots,*** he is using the left eye and suppresses the right eye.
   d. If the patient sees ***5 dots,*** ask the patient where the green ones:
      - If the red dots are to the right of green dots, he has Eso deviation.
      - If the red dots are to the left, he has Exo deviation.
      - If the red dots are above the green dots the patient has a left hyper deviation.
      - If the red dots are below, he has a right hyper deviation.

Recording:

- For testing flat fusion:
  - Record the distance at which the test was done.
  - If the patient sees 4 dots, record "***fusion***"
  - If the patient sees 2 dots, record "***suppression OS***"
  - If the patient sees 3 dots, record "***suppression OD***"
  - If the patient sees 5 dots, record "***diplopia***" and the type of deviation:
    a. Green dots to the left ***"Eso"*** (uncrossed diplopia)
    b. Green dots to the right ***"Exo"*** (crossed diplopia)
    c. Green dots above red dots ***"R hyper"***
    d. Green dots below red dots ***"L hyper"***
    e. Combination of vertical and horizontal deviation is possible.

MADDOX ROD TEST

Purpose:

To measure the horizontal and vertical phoria at distance and at near.

Indications:

The Maddox rod phoria test is an alternative to the von graefe phoria technique. It is used when the patient is unable to see two targets on the von graefe test or when the phoria test must be done in space rather than behind the phoropter.

Since this test can be done in free space with the patient wearing glasses, it is particularly useful for ruling out a prism induced vertical phoria due to a patient's head tilt behind the phoropter lenses.

Equipments:

- Penlight for near testing
- Dot light for far testing
- Maddox rod (red or white)
- Prisms (Risley prisms, prism bar, or hand held prisms)

Set up:

The Maddox rod phoria can be done at distance and at near, using the phoropter and risley prisms, or in space, using a hand held Maddox rod and loose prisms or prism bar.

Set up:

- The examiner turns on the dot light for distance testing. The examiner holds the penlight at 16 in for near testing.
- The patient wears his distance correction for distance testing, and his near correction for near testing.
- The patient holds the Maddox rod over his right eye as follows:

a. For measuring horizontal phoria, the grooves on the Maddox rod are oriented horizontally. The patient sees a vertical streak.
b. For measuring the vertical phoria, the grooves on the Maddox rod are oriented vertically. The patient sees a horizontal streak.

- The examiner holds the prism bar over the patient's right eye as follows:
  a. For measuring the horizontal phoria, the prism is oriented base in with sufficient prism to move the streak to the right of the spot of light.
  b. For measuring the vertical phoria, the prism is oriented base up with sufficient prism to move the streak below the spot of light.

Step by step procedure:

1. Instruct the patient to look at the light but to be aware of the red or white line.
2. For the horizontal phoria measurement, reduce the base in prism until the patient reports that the streak is in the center of the light.
   Note the amount of prism and the direction of the base.
3. For the vertical phoria measurement, reduce the base up prism until the patient reports that the streak is in the center of the light.
   Not the amount of prism and the direction of the base.

Recording:

- Record D for distance and N for near.
- Record the horizontal and vertical phorias separately.
- Record the size of the deviation in prism dioptres.
- Record the direction of the deviation.
- Indicate the type of Maddox rod used (red or white).

BRUCKNER TEST

Purpose:

To assess the symmetry of binocular fixation by comparing the brightness of the red reflex in each of the two eyes. This test is used to screen for strabismus, anisometropia, media opacities, and posterior pole anomalies in infants and young preverbal children.

Equipment:

Direct ophthalmoscope.

Set up:

- The patient removes his correction.
- Room illumination should be dim.
- The examiner holds the ophthalmoscope.
- The Bruckner test should be done with nondilated.

Step by step procedure:

1. Direct the ophthalmoscope toward the patient’s eyes from a distance of 80 to 100 cm with the beam of light illuminating both pupils.
2. Instruct patient to look at the light.
3. The examiner positions his eye directly behind the peephole of the ophthalmoscope and dials in the lens that gives a clear view of the patient’s pupils.
4. Observe the Hirschberg reflexes against the red reflex in the pupil.
5. Compare the brightness of the red reflexes in each of the two eyes.
6. The eye which has brighter red reflex is the deviated eye.

Recordings:

- If the right eye has a brighter red reflex record: Right eye deviation.
- If the left eye has a brighter red reflex record: left eye deviation.

HIRSCHBERG TEST

Purpose:

To determine the approximate positions of the visual axis of the two eyes under binocular conditions.

This test is used to identify a strabismus when other more precise methods cannot be used.

Equipment:

1. Penlight
2. Occlude

Set up:

1. The patient removes his glasses.
2. The examiner holds the penlight.

Step by step procedure:

1. Direct the penlight toward the patient's eyes from a distance of 50-100 cm.
2. Instruct the patient to look at the light.
3. Occlude the patient's left eye.
4. Place your eye directly behind the penlight and observe the location of the corneal light reflex in the right eye. There are 3 possible positions for the corneal reflex:
   a. The center of the pupil (zero angle lambda)
   b. Slightly nasal to the center of the pupil (positive angle lambda)
   c. Slightly temporal to the center of the pupil (negative angle lambda)
5. Occlude the patient's right eye. Repeat step 4 observing the left eye.
6. Remove the occluder. Position your eye directly behind the penlight and observe the location of the corneal light reflexes in each of the patient's eye with both eyes open.

7. Compare the locations of the corneal reflexes in each of the two eyes relative to where they were located with each eye fixating separately:
    a. If the reflexes are in the same relative positions in each of the two eyes, the patient doesn't have strabismus.
    b. If the reflexes are not in the same relative positions in either eye, the patient has a strabismus.
       Determine the direction of the deviation by observing the position of the two reflexes relative to the position of angle lambda in the fixating eye.
    c. The size of the strabismus can be determined by measuring the distance from the position of the reflex in the deviated eye to the position where the reflex would be if the patient didn't have strabismus.

Recording:

- If there is no strabismus, record "symmetry" or "Ortho".
- If there is a strabismus, record the eye that is deviated, the size of the deviation, and the direction of the deviation.

Position of the corneal reflex relative to position of angle lambda in the fixating eye	Type of deviation
Nasal Temporal Above below	Exo Eso Hypo Hyper

NEAR POINT OF CONVERGENCE (NPC)

Purpose:

To determine the patient's ability to converge the eyes while maintaining fusion.

Equipment:

- Penlight or transilluminator.
- Red glass.
- Near accommodative target (reduced snellen letter taped to a penlight or tongue depressor: four different sizes in the range of 20/25 to 20/200 are needed).
- Overhead lamp.
  Note: the penlight is used as a target for initial screening. The penlight with red glass and the accommodative target are used when the near point of convergence is greater than 7 cm/ 10 cm or when a complete binocular workup is being done.

Set up:

- The patient wears his habitual near correction.
- The overhead lamp is directed toward the target.
- The penlight (or other target) is held by the examiner at 40 cm.

Step by step procedure:

1. Instruct the patient to look at the light (or other target) and to report how many targets he sees. If the target appears double, move it further from the patient until it appears single before proceeding with the test.
2. Move the target toward the patient, observing the patient's eyes until the patient reports that the target appears double or until you see one eye lose fixation on the target. Note the distance from the patient's eyes at which the patient reports that the target doubles or at which you note that the patient loses bifixation. This is the break point.

3. Move the target away from the patient's eyes and note the distance at which the patient's deviated eye regains fixation. The patient will report single vision at this distance if he reported diplopia in step 2. This is the recovery point.
4. If break and recovery are closer to the patient than 7 cm, record the result. If the NPC is greater than 7 cm record the result and then repeat the test using the penlight with a red glass placed over the patient's right eye. Then repeat the NPC a third time using an accommodative target.

Recording:

- Record NPC and sc or cc.
- Record the target used:
  "Lite" for penlight
  "RG" for penlight with red glass
  "Accomm" for accommodative target
- Record the linear distance (in cm, mm, in, or ft) at which the eye deviated or at which the patient reported diplopia (break).
- Record the distance in cm, mm, in, or ft at which the eye regained fixation or at which the patient reported single vision (recovery).
- Record which eye deviated and in which direction, if you were able to make this observation.
- Record diplopia if the patient reported seeing two targets. Record suppression if the patient didn't report seeing two targets but a break was observed.
- If the examiner was able to move the target to the bridge of the patient's nose without the patient's losing fixation, record TTN (for "to the nose").
- Repeat this recording for each target used.

COVER TEST

Purpose:

To assess the presence and magnitude of a phoria or strabismus (tropia). The cover test assesses the presence or absence of motor fusion. When motor fusion is present (when there is no strabismus), the cover test determines the magnitude of the demand placed on a patient's Fusional vergence system.

Equipment:

1. VA chart.
2. Near cover test target.
3. Occluder.
4. Overhead lamp.
5. Horizontal and vertical prism bars.

Set up:

- The patient wears his hapitual correction for the distance being tested.
- Set up the target:
  For distance: an isolated letter, one line larger than the VA in the patient's poorer Seeing Eye (with best correction).
  For near: an accommodative target, held at 16 in. Use a reduced snellen letter one line larger than the VA in the patient's poorer seeing eye or a picture target of comparable detail. The patient may hold the target.
- The examiner holds the occluder.
- The examiner or patient holds the prism bar or bars.
- The room illumination must be sufficient to allow the examiner to observe the patient's eye movements. The cover test may be done with full room illumination.
- The examiner must be positioned to see the patient's eyes easily without interfering with the patient's view of the target.

Step by step procedure:

Alternating cover test:

Determines the direction and the magnitude of a phoria or tropia but doesn't differentiate a phoria from a tropia.

1. Instruct the patient to look at the target and to keep it clear.
2. Place the occluder in front of the patient's right eye for 2 to 3 seconds.
3. Quickly move the occluder from the patient's right eye to the left eye, observing the just-uncovered right eye for direction of movement.
4. Leave the occluder in front of the left eye for 2 to 3 seconds.
5. Quickly move the occluder from the patient's left eye to the right eye, observing the just-uncovered left eye for direction of movement.
6. Repeat step 2 through 5 several times.
7. Identify the direction of the deviation based on the direction of movement of each eye as it was uncovered.
8. The magnitude of the deviation can be measured using a prism bar. Place the prism bar over either eye as close to the eye as possible with the base in the appropriate direction.
   Repeat the alternating cover test while increasing the amount of prism held before one eye until no movement is observed on the alternating cover test.

Direction of eye movement as eye is uncovered	**Direction of deviation**
In	Exo
Out	Eso
Up	Hypo
Down	Hyper

Direction of deviation	**Direction of prism base for neutralization**
Exo	Base in
Eso	Base out
Hypo	Base up
Hyper	Base down

Cover-uncover test:

Differentiate between a phoria and tropia and determines if a tropia is alternating or unilateral. The cover part of the cover-uncover test differentiates phoria from tropia by determining the position of the visual axis of each eye when both eyes are open to view the target. If the patient has a phoria, each visual axis will be aligned with the target when both eyes are open. If the patient has a tropia, one visual axis will be aligned with the target and the other visual axis will be misaligned with the target when both eyes are open. During the cover-uncover test, only the unoccluded eye is observed to determine the position of its visual axis.

The uncover part of the cover-uncover test differentiates alternating tropia from unilateral tropia (constant right or constant left tropia). A patient with an alternating tropia is able to keep either the right or left visual axis aligned with the target when both eyes are open. A patient with a unilateral tropia habitually fixates with one eye when both eyes are open, and only fixates with the troping eye when the fixating eye is occluded. The examiner observes the eye that is not covered by the occluder.

9. To test the left eye, start with both eyes open and cover the patient's right eye. Observe the left eye for movement as soon as the right eye is covered. If there is no movement, it indicates that the left eye was fixating on the target at the start of the test when both eyes were open. Remove the occluder and allow 2 to 3 seconds for the two eyes to resume their normal relationship to one another. Repeat.
10. To test the right eye, start with both eyes open and cover the patient's left eye. Observe the right eye for movement as soon as the left eye is covered. If there is no movement, it indicates that the right eye was fixating on the target at the start of the test when both eyes were open. Remove the occluder and allow 2 to 3 seconds for the two eyes to resume their normal relationship to one another. Repeat.

11. If there is no movement in either step 9 or 10, the patient has a ***phoria***. Under normal binocular conditions both visual axis are aligned with the target.
12. If there is movement in either step 9 or 10, the patient has a ***tropia***. To differentiate between an alternating tropia and a monocular (right or left) tropia, start with one eye covered and observe the uncovered eye for movement as soon as the occluder is removed:
    a. If the left eye moved when the right eye is covered during step 9, uncover the right eye and observe the left eye.
        - If the left eye doesn't move when the right eye is uncovered, the patient has an alternating tropia.
        - If the left eye moves when the right eye is uncovered, the patient has a constant left tropia.
    b. If the left eye didn't move during step 9 when the right eye was covered, but the right eye moved during step 10 when the left eye was covered, then uncover the left eye and observe the right eye.
        - If the right eye doesn't move when the left eye is uncovered, the patient has an alternating tropia.
        - If the right eye moves when the left eye is uncovered, the patient has a constant right tropia.
13. The alternating cover test and the cover-uncover test are done at distance and at 16 in with the patient or the examiner holding the near target at eye level in good illumination

Recordings:

- Write "cover test" or "CT".
- Write "sc" for without correction or "cc" for with correction.
- Record separately for distance "D" and for near "N". The near results can also be indicated by adding a prime (') after the findings.
- Record the amount of prism that was required to neutralize the deviation.
- Record the direction of deviation, using the following abbreviations:
    - **E** for Eso, **X** for Exo
    - **RH** for right hyper, **LH** for left hyper

- No horizontal deviation
- No vertical deviation
- Ortho

- Record the type of deviation (phoria or tropia) using the following abbreviations:
  P for phoria
  T for tropia
- F the deviation is tropia, record “R” or “L” or “alt” for right, left, or alternating tropia.
- A **T** written in parentheses (T) indicates an intermittent tropia. If the tropia is intermittent, the percentage of time that the tropia is present should be estimated and recorded.

purpose	**technique**
Determine the direction of deviation	Alternating cover test
Determine if the deviation is a phoria or tropia	Cover part of the cover-uncover test
Determine if a tropia is an alternating, constant	Uncover part of the cover-uncover test
Measure the deviation	Repeat the alternating cover test using prism to measure the deviation

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Contents